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ABSTRACT

The case histories of water and sanitation schemes described in this volume can best be understood by identifying the moments at which critical hurdles were encountered and surmounted. The first case study, which concerns Bangladesh, discusses promising prospects that existed amid the pollution and the technical and managerial expansion of the crash phase of 1972-1976. Also discussed are moves towards community participation; the linking of water to sanitation and health; increased community outreach and changing technological challenge in the 1980s; and the broadened health impact. The second case study, which concerns India, describes program management in the 1970s; the process of advancing technology through handpump innovations; community involvement and maintenance; the move from technology transfer to capacity-building in hardware; the public health dimension of strengthened software; a push for water for all in 1985; and dracunculiasis eradication. The third case study, which concerns Nigeria, offers a blueprint for multisectorial and integrated action using low-cost technology. Topics include promotion of behavioral change through health education; the adoption of drilling and borehole technology; the move from pilot project to national strategy; evaluation of the impact on health; a redesigned software strategy; and the process of scaling up rural water projects. (RH)

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Maggie Black

From Handpumps to Health

The evolution of water and sanitation programmes in Bangladesh, India and Nigeria

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Maggie Black

FROM HANDPUMPS TO HEALTH

The evolution of water and sanitation programmes in Bangladesh, India and Nigeria

United Nations Children's Fund
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INTRODUCTION

INTRODUCTION

Water and sanitation: Towards universal coverage

The International Drinking Water Supply and Sanitation Decade (IDWSSD), 1981-1990, set out with a great aim: "Water and Sanitation for All". The underlying rationale for the declaration of the target was the worldwide improvement in overall health and quality of life, and the specific reduction of water- and dirt-related sources of disease that would accompany its achievement. Water and sanitation services are regarded as one of the essential components of primary health care. The IDWSSD goal was one of the targets established in 1978 by the Alma Ata international health conference sponsored by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) with the aim of reaching "Health for All by the Year 2000".

Transforming the prospects in rural areas

Predictably, people least well-served with water supplies and sanitation facilities are those most lacking social and economic amenities of any kind, namely, the rural people of the developing world. At the beginning of the Decade, global coverage for rural water supply was 35 per cent; and for rural sanitation, 13 per cent. In many of the poorest countries, the picture was a great deal grimmer. The predicament of this particular population group and strategies for meeting its needs have been a special focal point for IDWSSD's attention, producing some of its most creative activity. In a real sense, the Decade has transformed water and sanitation prospects for the rural people of the developing world.

Nonetheless, for developing countries in 1990, an estimated 1,230 million people (31 per cent) are without access to adequate and safe water supplies, and 1,740 million (43 per cent) without access to appropriate sanitation. The IDWSSD goal of full coverage is now rescheduled for the year 2000, to coincide with that of "Health for All". It is clear that the 1980s implementation rates would have to be increased about two-and-a-half times for urban water and one-and-a-half times for rural water, while urban sanita-

tion and rural sanitation would have to triple and quadruple, respectively, in the course of the 1990s to ensure 100 per cent coverage by the year 2000.

If coverage is to be the sole criterion of assessing the Decade's progress, the notion that any transformation in any area, rural or urban, has occurred would be unconvincing. Yet international organizations most closely involved in the IDWSSD generally agree that the Decade has been a success. The reason is that it has provided both catalyst and context for a maelstrom of activity in national and international water supply and sanitation, leading to a new range of technological, strategic and programmatic tools. The most innovative are those specially shaped for the less developed rural areas, many of which have been and are being adopted as part of national IDWSSD strategies.

This development, while still far from reaching its full potential impact on policies and programmes, has narrowed the gap between rhetoric and reality. For the first time, there is widespread political commitment around the world to the task of designing and putting in place water and sanitation services in rural areas. At the beginning of the Decade, the target of "Water and Sanitation for All" was no more than a high-sounding aspiration.

Devising low-cost appropriate technologies

The key to this development has been the recognition that low-cost installations that depend neither on conventional sewerage and pipe-borne water supply, nor on costly supplies of fuel or sophisticated engineering skills for their operation, have to be brought within the range of technological options for the design of water supply and sanitation services. Dams, reservoirs, pipelines and treatment plants, and in the home, faucets and flush toilets, are not the only installations worthy of public health engineering attention. The modest handpump, the lowly latrine, and other simpler and cheaper devices have come into their own as the cornerpiece of an entirely different kind of public service. Not only is it a radically cheaper service (US$50 per head instead of US$550, according to the latest UNICEF calculation of May 1990), but it is one with the potential for technology transfer, local manufacture and employment, and the development of an independent water well industry to back up, and in some cases gradually take over, the functions of the conventional public health engineering service.

If low-cost options for rural services have won a number of converts during the Decade, there is nonetheless a long way to go. Not all public health departments have yet accepted the new creed, although sceptics are now in the minority. Where these options have been accepted, there is still a gargantuan task ahead. More water points and waste disposal units have to be installed at rates that do more than keep pace with population growth, and they have to be incorporated into the social and economic fabric of community life so that their continued maintenance and operation do not present major obstacles to effective service delivery.

Managerial requirements

Where a community's water and waste disposal system is in the hands of a publicly funded central authority that controls faucets and flows at a distance from the users, management of the service is a specialized affair. Services based on handpumps and latrines in rural areas are different. No central authority turns on the taps and pulls the levers. They have to be managed on a day-to-day basis by the users, and if the users are not equipped technically and organizationally to do so, management and maintenance will falter. The repair of broken pumps and pipelines will depend on visits by engineering authorities who, by definition, cannot always be in attendance. It has taken time for these implications to be appreciated at the policy-making level. Low-cost, low-technology water and sanitation engineering issues present certain challenges that are far less complex than the management issues to which, financially and organizationally, they are inextricably tied.

In their turn, operation and maintenance issues are inextricable from the health rationale that is at the heart of the international commitment to "Water and Sanitation for All". Unless services are maintained and sustained, they have little chance of realizing their potential impact on people's health - an impact which has proved unexpectedly elusive.

Involving the community

Unless habits concerning water use and excreta disposal change, and the value of such changes can be observed and experienced over time by those who make them, there is often little reduction in the incidence of water- and sanitation-related diseases. Few medical conditions caused by biological or chemical impurities in the drinking water supply can be remedied without the community's participation and co-operation. Installation of such water and sanitation services is, obviously, a prerequisite if community health is to benefit, but it is far from being the sole determinant.

The demand for water supplies among rural populations in developing countries, and therefore their popularity, is driven not by the promise of improved health, but by the enormous gain in accessibility to something fundamental to human existence. Demand for sanitation in rural areas is similarly driven by motives not directly connected with health, but usually by the desire for privacy in places where opportunities for natural seclusion become fewer as habitation becomes more crowded.

Health education as an agent of behavioural change

Closing the attitudinal gap between those who demand and those who supply water and sanitation services is one of the issues that more and more national water and sanitation programmes are

trying to address. Few have yet bridged that gap. The debate about how to run health education programmes effectively and who to designate as the agents of sanitary change among service users is far from over. As with any social development programme concerned with imparting knowledge in the hope of changing human behaviour, a range of messages and communication channels are needed. What proves effective in one corner of the world may not be an appropriate strategy in another.

Targeting and mobilizing women

In this context, the major change the Decade has witnessed is the recognition that since women are the arbiters of health behaviour in the home, as well as the usual haulers of water, ways must be found of targeting women with health education messages. It has also become clear that if women are to be the prime recipients of information about water use and sanitary practice, they should be enlisted in the management end of things.

Synergistic and non-sequential development

Rural water supply and sanitation service development embrace technological and engineering issues, management issues and health impact issues. All are interrelated, and service effectiveness as well as cost effectiveness can only result from their linkage. However, the evolution of most rural water and sanitation programmes up to now has followed a pattern in which these issues have been addressed in chronological sequence.

The problems development programmes address at their genesis are very different from those that surface as the programmes evolve. In the early 1970s, the challenge of finding a sufficient quantity of water in certain formations, and bringing it successfully to the surface, logically and necessarily eclipsed all others. Geographical spread and the percentage rate of successful boreholes were the principal measures of water supply progress, while sanitation programmes were almost non-existent. A programme planned in such a way as to accomplish this feat several thousand times over, in a co-ordinated fashion, was then a revolutionary concept. There was no reason to assume its benefits would not flow as naturally and surely into the community as did the water rising from the ground.

The accumulation of experience and new scientific data acquired along the way by the early water and sanitation pioneers has dramatically altered original perspectives. In the course of the Decade, it has become possible to search for ways of speeding up different elements and stages in the programme process, even to the

extent of launching properly interlinked water supply and sanitation programmes that address technical, managerial, social and health impact problems simultaneously.

During the IDWSSD, the more usual pattern of approaching critical policy issues has been of addressing them sequentially. The technological issues - appropriate technologies, improved designs, reformulation of design criteria to emphasize easy maintenance, research and development (R&D), local manufacture and technology transfer - were the preoccupation of the first half of the Decade. Management issues - human resources development, village-level operation and maintenance systems (VLOM), the involvement of women, cost recovery - have received the lion's share of attention in the middle years. Health impact issues - eradication of dracunculiasis (Guinea worm), reduction of diarrhoeal disease, health education campaigns, built-in linkages between water supply provision and latrine construction - are now coming fully into their own. The new target of reaching "Water and Sanitation for All" alongside "Health for All" by the year 2000 provides a clear illustration of the latest emphasis.

From emergency response to sustained development action

UNICEF became involved in rural water - and later, sanitation - programmes on a significant scale largely as a result of drought, flood and other chronic emergencies. It is not a coincidence that disasters of one kind or another have played a catalytic role in launching some national rural water supply programmes. Disasters, whether cataclysmic in their nature or of the gradual variety, are often critical indicators of development failure.

The famine and flood emergencies of the late 1960s and early 1970s, which precipitated UNICEF's involvement in large-scale rural water supply schemes in some countries, served to expose the need for a systematic developmental approach. In India, the groundwater table was dropping, and increasing numbers of villages in hard rock areas were facing perennial water shortage. In Bangladesh, the public health hazards had to do with the level of contamination in the over-abundant surface water. Since UNICEF directs its assistance towards the most disadvantaged women and children, it was naturally driven to help schemes in rural areas, using the simplest and cheapest technology available.

These schemes, among others, have turned out to be the testing grounds for the low-cost approaches that the IDWSSD has raised to prominence. During the 1970s, the major international investors in infrastructural development gradually took up the low-cost technology approach to water and sanitation in rural areas. They began at the technological end of the spectrum, putting into R&D the resources and attention that have helped to institutionalize the low-cost approach.

Translating water and sanitation services into improved health for women and children

Nowadays, UNICEF is only a minor player in the technological league, and an even more minor player in financial investment terms; but it is still a major player in facing the continuing practical challenges, particularly the translation of water and sanitation services into improved women's and children's health.

Since the average annual resources at UNICEF's disposal for water supply and sanitation are limited - US$70 million a year, out of US$3.5 billion annually allocated by all external sources, plus the US$6.5 billion a year by the developing countries themselves (averaged out over the Decade) - its special contribution is the length and relevance of its experience with low-cost approaches; its close working partnership with certain national programmes during the key stages of their evolution; and its consistent effort to use its few resources meaningfully by remaining at the frontier of problem solving, withdrawing support in areas where technological or managerial capacity building have moved beyond the teething stage. Notwithstanding its minuscule financial contribution to water and sanitation, UNICEF support for such projects, when combined with the inputs of approximately 90 countries, attains an average of 12 per cent water supply service coverage per annum.

The period over which the IDWSSD has pushed coverage objectives for Rural Water Supply and Sanitation Services (RWSS) higher on national agendas has coincided with UNICEF's articulation of a strategy for Child Survival and Development. This intensification of effort for reducing infant and child mortality and morbidity has prompted UNICEF to give more emphasis to links between water, cleanliness, childhood disease (particularly diarrhoeal disease) and nutritional deficiency, and to search actively for ways to combine water and sanitation approaches with primary health care. In some countries, community-level cadres originally trained to support water and sanitation activity have been recruited as immunization campaign personnel.

Many influences on the programming process are, therefore, simultaneously pushing RWSS in the same direction: away from a narrow focus on engineering technology and towards maximizing health impact in the community. One result is the popularity of the latest "integrated programme approaches", which use community demand for water as a lever for promoting household latrine construction.

In the continuing quest for accelerated progress towards universal coverage, UNICEF believes that it is important to analyze the experience of those programmes that have managed to move a considerable distance along the technology/management/health-impact continuum, and thereby contribute concretely towards the goal of national coverage. The case histories of water and sanitation schemes described in this volume begin with the premise that their evolution can best be understood by identifying those moments at which critical hurdles were encountered and surmounted, in order to move to the next stage of programme growth in any given area.

A basic assumption is that there is no one right way, no one correct technological or strategic response, but that the right mix in the particular circumstances, achieved partly by prior planning, partly through trial and error, is the most effective way forward. Therefore, what emerges is not a blueprint, but an indication of what tensions or obstacles are likely to occur at certain stages and what needs to be taken into account in devising strategies to overcome them. Strategies do not emerge as definitively good or bad. More important is whether other developments - in local managerial capacity, for example - have themselves evolved sufficiently for a given strategy to work. In Bangladesh, for example, community self-help as a strategy for borehole installation failed when it was first tried out. Many years later, it is an RWSS showpiece.

Each case history is written according to an evolutionary format. Key events in the different contexts - technological, management, social - were identified and placed in a chronological order.

With all the vicissitudes facing social services in the rural third world of the late 1980s, the extraordinary progress in water supply and sanitation is something of which all its actors at national and international levels can be proud. If these case histories do not always reflect smooth progress, it is purely because they seek to emphasize the bumps on the road towards that attainable goal. UNICEF hopes that lessons can be learned from this account that will ease the passage of other programmes less well advanced along their way.

CASE STUDY I

BANGLADESH

BANGLADESH

Promising prospects amid pollution

In 25 years, the tubewell has replaced the open pond as the primary source of drinking water for more than three-quarters of Bangladesh's people. In a land of water abundance, this is not because of scarcity, but because the Public Health Engineering authorities have generated demand for an item of household improvement and convenience.

Unfortunately, this revolution in safe water consumption has not yet been matched by a drop in diarrhoeal disease, the country's foremost killer of young children. This is because the densely populated water-washed environment is heavily polluted, and will remain so until the sanitary latrine becomes as popular a consumer item as the tubewell.

The prospects are beginning to show promise. They derive from the history of the water supply programme's development and the steady expansion of its technological, managerial and socio-economic capacity. This case study examines the nature of their successes and looks at how efforts are being made to apply them to help promote child health.

The topography of Bangladesh is moulded by water. The country sits astride the confluence of two of the world's greatest rivers, the Ganges and the Brahmaputra, and its patchwork of low-lying land is distributed between thousands of their tributaries. Every year during the monsoon months from June to September, the rivers, descending from the Himalayas towards the Bay of Bengal, disgorge their burden of melted snow across the plains of the delta. Layer upon layer of paddy-field gradually disappear beneath the floodwaters as more than one-third of the countryside is inundated.

This has a profound effect on every aspect of life in Bangladesh. The annual floods can bring tragedy. In 1988, following an exceptionally wet season in 1987, more than one-quarter of the population - 28 million people - were driven from their homes by floodwater. Yet, in a normal year, these streams and lakes, spilling out into the distance with their cargo of silt from upstream, are Bangladesh's life support system, and the landscape - houses high on plinths, roads on causeways - is ready to receive them. They dominate the occupational and living patterns of the 90 million Bangladeshis who live in the rural areas and comprise 88 per cent of the country's population.

The rivers' gift is an extraordinary fertility which permits the shifting mass of soil to support, by the thinnest of margins, the highest density of agricultural population in the world. The negative side of the picture is that the country takes on the character of a massive open drain. The water flows freely through the heavily populated land, picking up and carrying along its residue of dirt, germs and unhealthy detritus. The constant uncontrolled and uncontrollable contact between people and surface water constitutes a public health problem of unparalleled proportions.

The public health context

In most of rural Bangladesh, the public health system in any formal sense is non-existent. There is a large selection of natural washing tubs, bathing pools and lavatories lying within easy reach of everyone's home. People use the local ponds and streams as sewers without realizing that they are polluting their environment and exposing themselves, and their children, to constant risk of disease. They bathe once or more a day, carefully removing their garments to wash them, with little notion that their ablutions are as hazardous as they are cleansing. Children plunge in, submerging their faces and emitting a stream of water from their mouths as they come to the surface. Eighty per cent of disease in Bangladesh is related to unclean water. Diarrhoea accounts for 30 per cent of deaths in children under five years old.

The typical context of efforts to provide a permanent year-round supply of potable water for rural families in the developing world is water scarcity. The opposite is the case in Bangladesh, where the context is an excess of water. The unsanitariness of the country's rural environment, in which the abundance of surface water is as crucial a factor as its degree of pollution, constitutes the reason why an alternative source of drinking water and a system of containing waste are necessary. Ready access to water and the energy-saving benefits for women are less important in such a context. From the programme planners' perspective, the health imperative is *the* imperative.

Generating popular demand for water and sanitation

The national rural drinking water supply programme has a history stretching back several decades. Its major period of expansion began with serious UNICEF involvement from 1972. The incorporation of village sanitation came later, in 1978. The most remarkable feature of the programme is that, over 20 years, it has created a countrywide demand for tubewell drinking water and, more recently, a growing demand for sanitation too.

The switch to tubewell water amounts to a revolution in water drinking habits. A generation ago, everyone in rural Bangladesh drew water from open ponds. The leading village landowner reserved special ponds for community drinking purposes, with enough

Fig. 1: RWSS Programme - Bangladesh Annual Government and UNICEF funding

water to last through the dry season. Use of the reserved pond was governed by rules for keeping the water clean, rules maintained by the landowner's authority in a tightly knit community. The erosion of traditional social hierarchies, coupled with population pressure, make it nowadays very difficult to ensure a similar form of protection for any open source.

The rural water supply programme has replaced the reserved pond with the tubewell. By the mid-1980s, 80 per cent of the people in Bangladesh drank handpump water drawn from underground. Twenty years ago, the installation of a public tubewell would elicit complaints about noise, mud and nuisance from householders living close by the pump. Nowadays the axiom is: "Marry your daughter to a man with a tubewell handpump."

Except for the coastal belt and the few hilly areas, there are handpump tubewells everywhere in Bangladesh today. Close to half a million have been installed by the Government since 1972 and the average number of people served has dropped from 400 per pump to 135. Another half million have been entirely installed at private initiative. Shops in every small town sell handpump spares and in every rural community people make a living off the handpump business as drillers, fitters, repairers and plumbers. This has all come about as a direct result of the national rural water supply programme run by the Department of Public Health Engineering, which is assisted by UNICEF, WHO and other supporting agencies.

If the new-found demand for tubewell water is not a response to outright scarcity, neither, unfortunately, does it reflect a change in consciousness about the relationships between water, dirt and disease. Rather, it is because a tubewell and handpump have become a desired consumer item, something households want as a quality of life improvement, much as people elsewhere want refrig-

erators or washing-machines. In similar fashion, demand is now building for the sanitary latrine. Although still far from being universally perceived as an important household convenience, the latrine is gradually growing in popularity, raising its coverage rate from zero to four per cent of rural homes in less than 10 years. A major advantage of having secured the tubewell's future is that the programme can capitalize on its popularity to help build up demand for latrines in their turn.

The health gains, so confidently anticipated when the programme build-up began in 1972, have yet to be realized. Infant and child mortality rates show no marked decline. The widespread use of tubewell drinking water has made almost no detectable impact on the rates of diarrhoeal disease and parasitic infection. The problem is that drinking tubewell water will not protect the health of children unless there is a parallel improvement in environmental sanitation hygiene awareness.

This is the challenge that the rural drinking water and sanitation programme in Bangladesh is now engaged in meeting.

The genesis of the programme (from the 1940s on)

The installation of public tubewells to tap groundwater from the alluvial soils of Bangladesh began many decades ago. Before 1948, 50,000 tubewells were constructed under the authority of the 20 district administrations. In the 1950s, the programme was centralized under the Directorate of Public Health Engineering (DPHE) and a further 22,000 tubewells were installed.

In the 1960s, efforts to speed up the rate of tubewell construction led to a radical decentralization of programme implementation. Resources were supplied by the DPHE, but effective control was put in the hands of the "Basic Democrats" (boards of elected representatives at the level of the Union - an administrative unit comprising several villages). Over 110,000 tubewells were installed over the next 10 years and more than 50,000 choked-up tubewells revived.

The fact that a technically competent agency had lost central control over implementation, however, had some negative consequences. Occasionally tubewells were poorly sunk. In some cases funds and materials were misused. The choice of sites was open to political influence and sometimes bore little relation to need as defined by the selection criteria. Many wells swiftly became inoperable and the programme's reputation suffered.

This experience had an important bearing on the programme's subsequent management structure, including the information and hydrogeological record-keeping systems introduced later and the subsequent attitude of the DPHE towards any abrupt decentralization process.

Although UNICEF made minor inputs to the rural water supply programme in the 1960s, the major external supporter was USAID. Until the early 1970s, the normal UNICEF policy was to restrict support for water supply and sanitation to primary schools and

health centres. Correspondingly, material assistance in the form of pipes, pumps and other supplies was usually negotiated as part of broader programmes of health or education. In 1967, however, because of the exceptionally high toll on children of water-borne diseases in the riverine environment of the Ganges delta, a programme of modest support for the construction of public tubewells and village tanks was approved.

A major subsequent change in UNICEF policy occurred because of a natural disaster. A catastrophic cyclone struck the coast and off-shore islands of Bangladesh (then East Pakistan) on the night of 12 November 1970, causing the deaths of around 300,000 people. As part of a rehabilitation programme, UNICEF decided to help improve tubewell drinking water supplies. The emergence of Bangladesh as an independent country at the end of 1971 marked the beginning of what has become a much larger, national programme of rural water supply co-operation.

The 12 months preceding independence had been marked by civil and political turmoil, during which there had been no maintenance of the country's 185,000 public tubewells and handpumps. As a result, a very high proportion needed replacement or repair. Over 10 million people who had fled across the border into India were returning home and movement in the countryside was unprecedented. The lack of even rudimentary health services, also badly damaged, and the contamination of open wells and village tanks gave rise to fears of epidemics of cholera and diarrhoeal disease on an uncontainable scale.

In its earliest discussions with the new Government, UNICEF concentrated on immediate needs. In January 1972, it agreed to provide the DPHE on an emergency footing with massive quantities of leather washers and buckets, nuts and bolts, for instant repair of handpumps. At the same time, the post-cyclone programme to sink deep tubewells in the coastal belt was reactivated and DPHE and UNICEF undertook a joint review of the country's entire drinking water situation. Since coverage would still be alarmingly low even if all choked-up wells were fully revived, UNICEF decided to expand its support to large-scale rural water supply development.

The plan drawn up for co-operation between DPHE and UNICEF for a country-wide village tubewell and handpump programme marked a turning point. The programme's physical targets were very ambitious: the sinking of 100,000 new shallow tubewells, 1,200 deep tubewells in the coastal area and the resinking of 60,000 tubewells choked up with sand - all to be achieved in two years.

Materials were to be provided by UNICEF at a cost of US$10 million. But the contribution went further. The DPHE was a small department of the Ministry of Local Government. The increase in programme scale, coupled with the "crash" rate of execution, required a major operational expansion. Without careful management and monitoring, the programme risked leaving behind a trail of silted tubewells and broken-down pumps. Devising a suitable system of implementation was a challenge faced by DPHE with full UNICEF co-operation.

1972-1976 — the crash phase: Technical and managerial expansion

The hydrogeological context of groundwater extraction in Bangladesh is highly favourable to low-cost, low-technology approaches. This has been an economic and technical bonanza to the programme from its inception.

The country sits upon a vast, spongy aquifer which is replenished by the rains (2,200 mm a year) and the annual inundation. As the floods recede, ponds and streams dwindle and the water table falls; but even in the dry season, it rarely drops below 15 metres. Until a few years ago, even that depth was exceptional.

The groundwater lies in layers of silty clay and sand. Below the clay skim lies a zone of fine and very fine sand layers descending to an average depth of 20 metres, beyond which the sand begins to coarsen. These layers act as a sieve, filtering and cleansing the polluted surface water as it gradually percolates down. There is often clean water at depths of 20 or 30 metres, but the average tubewell is sunk to a depth of around 50 metres, where the sand is coarser and helps to provide a barrier against the frequent problem of sand choking.

This hydrogeological environment is uniform throughout the country except in the northeast, the coastal belt and the Chittagong Hill Tracts. The soft soils, the absence of rocky obstructions and the proximity of the water table confer a technological blessing on tubewell installation. In most parts of the country, a tubewell can be sunk to a depth of up to 100 metres without the aid of any drill or mechanical device, purely by the use of human energy.

The indigenous method of tubewell sinking is called sludging. It is cheap, costing around US$0.30 per metre and it is well within the technical capacity of a mistri (village handyman) who needs no training, sophisticated equipment, or logistical back-up. Drilling by sludging eliminates the need for the authorities to hire drilling crews or purchase expensive equipment. Implementation can be farmed out to local contractors and costs kept to a minimum.

The type of handpump installed depends on the depth of the water table. In most areas of Bangladesh, this is never below seven metres and is therefore within the reach of a simple suction handpump. Where the water table is lower than this for all or part of the year, a pump capable of a greater lift has to be installed, its cylinder "deep-set" inside the well. In the early 1970s, the number of areas requiring deep-set below-ground handpump mechanisms were relatively few.

In the coastal belt of the country, sludging cannot be used for well sinking. Here, the groundwater at 100 metres is usually saline. In these areas, a hand-driven donkey-wrench is used for well sinking, at a per metre cost six or seven times that of sludging. The average depth of a deep well is 300 metres, although the water table is higher than seven metres and therefore suitable for the suction pump. Providing tubewells in coastal areas is a more expensive

proposition and, because the population is scattered, more logistically complex. As a result, the coastal areas have always had special problems with regard to drinking water supplies.

When UNICEF offered the materials to construct or resink 160,000 shallow tubewells, the immediate problem was how to handle the logistics. The critical items to be supplied were few, but were required in mass quantities: 17 million feet of pipe, over 200,000 well screens, 100,000 handpumps, 100,000 bags of cement for the construction of handpump platforms, 600,000 leather buckets and seat valves for pumps under production or repair and 20 tons of nuts and bolts. Most of these items were shipped to Chittagong and moved from there to stores and depots all over the country.

Improving managerial capabilities

It was clear that the existing DPHE was not sufficiently equipped to carry out the programme expansion envisaged. The Government decided to build up the DPHE managerially, technically and logistically.

Between 1972 and 1976, the DPHE underwent a metamorphosis, evolving a structure and staffing level which, except for the operational expansion into village sanitation in 1978, remains essentially unaltered today. In 1972, the administrative focal point of DPHE's programme operations was the sub-divisional level representing an area of roughly 1,000 square miles. Between 1972 and 1974, each of the 64 sub-divisional DPHE centres was put in the charge of an Assistant Engineer, supported by two Sub-Assistant Engineers (SAEs) and four tubewell mechanics, responsible for each of the country's 460 thanas (the next administrative level). Their main responsibility was to put the vast number of broken-down handpumps back into running order. By the end of 1973, the number of posts in the DPHE had doubled at almost every level.

Refining technical components: Stimulating local production

While the DPHE was undertaking this expansion, UNICEF began to examine the technical components of the tubewells and handpumps which the system was being designed to deliver. Given the high rate of pump breakdown, clogged tubewells and corroded pipes, any technical improvements that could be introduced would enhance the effective outcome of the programme very considerably.

One of the earliest improvements was the substitution of PVC for galvanized iron (GI) pipe for well casing. In the early 1970s, plastic piping for water schemes was coming into more general use and PVC was both cheaper than GI pipe and, being noncorrosive, much more durable. By early 1974, 12 million feet of PVC pipe had

been procured. This was its introduction to Bangladesh, which soon afterwards began developing its own PVC industry. Not only were pipes manufactured, but a switch from leather - scarce in Bangladesh - to PVC was also made for the buckets, or cup seals, used in the handpump.

The introduction of better and cheaper materials for local tubewell construction and production was regarded as a major success of the mid-1970s. It also had a spin-off effect. The production of plastics in Bangladesh stemmed directly from the demand created by the tubewell programme and is today regarded as an important Bangladeshi industry. The process of technological evolution, including experimenting with new materials and increasing the number and range of tubewell components manufactured in Bangladesh, has continued throughout the evolution of the programme.

Even more in need of technical improvement than the tubewell were the handpumps whose persistent breakdown was the inspiration for the "crash" phase of the programme. The quality of the standard pumps was poor. Two models were in use, the No. 4 and the No. 6, with the latter - a larger diameter pump - most commonly installed. Both were subject to rapid wear and tear, some parts lasting only six months. In 1972, only 50 per cent of the pumps were working. To repair the pumps and keep them operational required the deployment of a very large number of mechanics. Effort spent on improving and standardizing the pump seemed likely to show rapid return on investment.

UNICEF started by commissioning a design for a stronger handpump from the Batelle Memorial Institute of Columbus, Ohio. In 1973, what was thought to be an excellent model was replicated in local foundries in Bangladesh, but the large amount of costly imported metal needed for its manufacture turned out to be prohibitive. It was decided instead to incorporate the Batelle's functional improvements into a new version of the old No. 6 pump. Local foundries began manufacturing this cheap, simple and sturdy cast-iron workhorse, the New No. 6, in 1975. UNICEF imported both the pig-iron and the coke required to smelt it. By the end of the year, six foundries were turning out nearly 7,000 pumps per month, more than enough for an installation rate of 50,000 a year together with the necessary supply of spare parts.

The New No. 6 handpump was one of the key technological developments of the programme. This was a low-cost pump of no great distinction, with a lifespan of a decade or two at most. But it was an ideal pump for the local techno-economic context. It offered the prospect of a much lower breakdown rate and helped to standardize tubewell and pump components. It also aided the economy by boosting the private market in tubewell construction and by creating thousands of jobs in local foundries.

With some minor modifications, the New No. 6 remains the country's standard shallow well handpump. It has also been modified by UNICEF for use in the rural drinking water supply programmes in Nepal and Pakistan.

Towards community participation

The history of the rural water supply programme in Bangladesh has been characterized by a constant debate over how much control should be exercised by the technicians and how much by those in political and administrative control of local government. This debate, while it has had a creative influence on the programme's evolution, has also produced some unavoidable tension.

In the 1960s, control over the programme had been prematurely decentralized. By the mid-1970s, with DPHE back in charge, the sudden "crash" expansion had also affected the quality of the programme. The problems were those inherent in any rapid build-up of a service intended to meet a long-term developmental purpose. The sense of urgency served a valuable purpose in bringing the new DPHE managerial and logistical framework into existence. But the fast build-up created its own managerial problems: ad hoc appointments, inexperience, lack of job security, and lack of staff training and orientation to the goals of the programme, all of which were exacerbated by the uncertainty of future budgetary allocations. A price was paid for forcing the pace of a programme whose human and technical resources were still loosely welded.

Under the circumstances, the programme's rise in capacity to 50,000 new tubewells a year by the end of 1975 was impressive. Eighty per cent of the targeted 100,000 new shallow tubewells had been constructed, all 60,000 of the choked-up wells had been resunk and the post-1970 cyclone programme for the coastal area had been completed. Surveys showed that 60 per cent of households in Bangladesh now had a tubewell within 250 yards. Coverage per head was down from one tubewell per 400 people to one per 260.

The state of the programme's management was, however, less than satisfactory. A concern, voiced on all sides, was the number of unscrupulous contractors undertaking installation on behalf of DPHE who were sometimes misusing the programme's funds and materials. Inadequate supervision sometimes led to poorly constructed tubewells in unsuitable locations. The programme delivery system contained too much room for manoeuvre and too little accountability. In the worst areas, up to 50 per cent of the new tubewells were non-operational from the start.

Part of the problem lay in an inheritance of poor record keeping. The Basic Democrats had kept the scantiest of records about their water supply activities and there had been no systematic collection of hydrogeological data. As a result, there were no specified depths to which tubewells were required to be drilled; nor was there a ready listing of "reliable contractors of integrity, technical competence and financial stability" whose exclusive use was stipulated in the plan of operations. Thus, tubewells were frequently drilled too deep or not deep enough.

The weakness in the system was the lack of staffing at the intermediary level, between the sub-divisional DPHE centre and the hundreds of handpump sites out in the villages. In spite of its expansion, DPHE still had insufficient staff to supervise the selection

of sites and the activities of contractors operating in so many different locations. With responsibility for 1,000 square miles of handpump tubewell territory, the Assistant Engineer plus two Sub-Assistant Engineers - even where the sub-divisional centre had a full complement of staff - were too far removed from day-to-day field operations.

Mobilizing local resources: The Dhamrai experiment

The "crash" programme for public tubewell construction had been paid for entirely out of Government (and UNICEF) funds. In 1973, the Planning Commission issued a recommendation that the 155,000 new shallow tubewells (scheduled for construction under the First Five-Year Plan, 1973-78) be sunk with public participation and that all "local costs, of tools, equipment, materials, skilled and unskilled labour, be borne by beneficiaries/local governments." ("Local government" meant the new equivalent of the Basic Democrat: the Union Parishad, or council.) This led to an experiment with a different type of management and implementation structure for the programme. Its main motive was to save money for the Government, but it also provided an opportunity to try and do away altogether with the contractors and the leverage they were commanding.

In December 1973, the Chief Engineer of DPHE, drawing on advisory support from WHO and UNICEF, began to develop a pilot project. The site selected was Dhamrai, a thana about 30 miles away from Dhaka with a population of 235,000 and 16 Union Parishads. In April 1974, a DPHE office and store were set up, staff engaged and three skilled local mistris hired for tubewell sinking.

The schedule of works depended heavily on the co-operation of the Union Parishads. They had agreed to collect Taka 30 (approx US$1.00) towards the cost of each well and to supply labour to help the mistri with the sludging. Not until the cash was deposited and the labour force lined up could the mistri set up his scaffold and proceed. Immediately, problems began to emerge.

The Union Parishads had no difficulty coming up with the cash deposit, but they had major problems supplying the labour. Farmers were busy sowing and harvesting and were most reluctant to abandon their fields for tubewell duties. So the Unions were obliged to raise extra money to pay for their labour. When the labourers did finally appear, their ignorance of the sludging procedure meant that their work was poor and unreliable. As a result, the mistris frequently found themselves sitting idle, or obliged to hire extra hands to save a half-finished tubewell from collapse.

The project staff managed to complete 84 tubewells in the first three months, the period during which the new system was expected to prove itself. Of these, only six handpump platforms - also a responsibility of the Parishad - were constructed. Strictly speaking, only six installations could be regarded as complete.

This experiment proved beyond a doubt that there was no way in which the programme could be effectively implemented at this time by devolving so much responsibility to the community level.

The DPHE had found itself in the same predicament as in the 1960s: responsible for technical supervision, but without any effective control over implementation. Unless DPHE retained control, not only the rate of tubewell construction but the quality of the tubewell/water/handpump/platform package would suffer.

However, the Dhamrai experience also produced some very helpful results. First, it showed that there was money available in the community to support public facilities. Contrary to the idea that villages would only make contributions for community projects in labour or kind, the Union Parishads had found it relatively easier to produce cash contributions than to organize work parties. They had raised an average of Taka 200 per tubewell, equivalent to half the usual sinking costs. Second, the Dhamrai experiment proved that programme supervision was much better placed at the thana than at the sub-divisional level. Because of improved supervision, 84 tubewells were sunk instead of just a handful.

Decentralizing maintenance and supervision

Insights gained from the Dhamrai experiment helped the evolution of a workable design for the 1973-78 programme phase. The important change was decentralization of DPHE's operations so that the sphere of key activity was at the local level, where sites were being selected, tubewells sunk and handpumps installed. The locus of programme supervision was moved from the sub-divisional to the thana level and a DPHE store and office were planned for every one of the country's 460 thanas. A Sub-Assistant Engineer was put in charge, with four maintenance mechanics.

DPHE bore the burden of recruiting extra engineers, while construction, transport and other material costs were provided by UNICEF. The latter also increased its own cadre of field technicians responsible for monitoring at site level, ensuring that the contractors' performance could be checked. A new mix of technical, managerial and community responsibilities was in the making.

In 1972, the most conspicuous tubewell drinking water problem had been the breakdown of handpumps. Apart from questions concerning spare parts importation and the local manufacture of handpump components, the question of how to manage handpump maintenance rated a high priority from the outset. The intention was to develop a new system of maintenance that involved the users of the water supply, those with a vested interest in keeping the pumps in working order.

In the mid-1970s, alongside the introduction of the more durable New No. 6 handpump, a novel approach was tried out in selected Unions. Its principle was that the responsibility for maintenance would be borne by the Union Parishads, which would recover the cost of spare parts from the users. Since the No. 6 was a simple and unsophisticated device, a tubewell attendant, employed by the Parishad, would be technically able to manage its repair. Each Union would receive an initial stock of low-cost spare parts and put income from their sale into a revolving fund, which it would manage and use to replenish the stock.

The aim was that each of the 4,350 Union Parishads in Bangladesh would employ a tubewell attendant and set up a revolving fund for spare parts and community maintenance. However, that did not happen. But, starting in 1976, following the evidence from Dhamrai that soliciting community cash contributions for tubewell water was a practicable proposition, a system of charging users for half the cost of tubewell installation came into operation. Its introduction required a major change in the way handpump sites were allocated.

1) Site selection strategies

The number of new tubewells to be installed or resunk in each Union would, as before, be decided at the thana level. But the actual sites would be decided by user group submission of tubewell application forms through the Union Parishad Chairman. The list of sites would be drawn up, passed back up the line for approval by both DPHE and UNICEF and then the contractors would be hired to sink the wells.

Because they were going to make a cash contribution, future users were now involved in site selection. Applicants and Union Parishad Chairmen had become partners in this process, with the Union Chairmen acting as arbiters. For the first time, the active involvement of the people in the village had been incorporated into the mechanism of programme delivery.

2) Selecting the handpump caretaker

The new tubewell application forms required applicants to designate one of their group as the handpump "caretaker". The first task of this caretaker was to collect the money from the group should their application be successful. Thereafter, he was responsible for liaising with the Union authorities on matters concerning siting, state of repair, misuse or any other relevant issue.

Unlike other countries where the caretaker idea was then being introduced, the Bangladeshi caretaker was not a young person with a record card, a can of grease and some responsibilities for reporting breakdowns and keeping the handpump area clean. In the Bangladesh programme, the person listed as "Head of Community" on the application form was automatically designated "caretaker". This person, therefore, was often the most prominent and wealthiest among the applicants.

The application form had to be signed by members of 10 families, the minimum number that the new public tubewell would supply. These 10 families commited themselves to comply with the list of conditions governing the installation of a tubewell, including the site selection criteria. They also, in theory, contributed to the sinking costs. In fact, the usual practice was that the designated caretaker provided most or all of the necessary cash, reflecting his Head of Community status.

As the guardian of the handpump and as the person who paid for much of its installation, the caretaker tended to expect preferential treatment regarding its location. The role assumed was very similar to that of the owner of the reserved pond in the recent past. The caretaker had a natural inclination (reinforced by the tradition of confining women to the home) to have the pump positioned as close as possible to his own household and sometimes actually within his compound. Although these were public installations, some caretakers thought of them as akin to their own property. They would, as custom demanded, extend access to others in the village; but their authority over the well reflected the natural village pecking order.

3) Monitoring inequity

In an attempt to avoid inequitable siting, the tubewell application form was very carefully worded to ensure that the caretaker and other signatories had a full appreciation of the public nature of the service. The greatest care was taken in the design of the system of reviewing and approving applications. All came under the scrutiny of a Site Selection Committee, including thana and DPHE representatives, as well as the Union Parishad Chairman.

UNICEF district representatives received copies of the approved lists, inspected five per cent of the sites (which in most cases meant several hundred in a year) and were entitled to veto those that did not conform. They also inspected installed tubewells to see that they had been put in the place agreed and that the work was in other ways satisfactory.

Distance criteria were introduced to try and ensure a more even spread of tubewell coverage. Villages with no tubewell took priority, independent of their total population. Elsewhere, the target was to provide a tubewell for each 150 people. These principles have remained essentially unchanged since 1976.

The criteria for positioning a new tubewell in a village included convenient distance from all the prospective user families, as well as public health considerations and local hydrogeological conditions. No family was supposed to be farther away than 250 yards and no tubewell was to be situated within 500 feet of another, unless one of the two was in a bazaar or some other very crowded place. As overall coverage grew, the distance criterion was reduced.

The selection process for siting tubewells was - and is - one of the key tests of the programme's ability to reach the poorest families who must rely entirely on public water amenities. In 1976, DPHE and UNICEF were trying to develop easily applied uniform procedures for the nation as a whole and, at the same time, to devolve certain responsibilities to the community through household heads. The difficulty was to do so in a socially equitable manner, with built-in safeguards to prevent better-off community members from monopolizing subsidized public wells on or near

their property while the less well-off languished at the end of the line. Hence the importance of the site selection criteria and their proper application, even though the process continues to be an area of tension both within the programme and among its external supporters and observers.

4) Maintenance aspects

The designation of the Head of Community as the handpump caretaker also had implications for the pump's state of repair. Usually a man of relatively greater means than his neighbours, he was able either to ensure that the tubewell mechanic came promptly to repair a broken-down pump or to employ a local mistri to do the work instead.

The new maintenance system, using Union-based tubewell attendants, was selectively introduced in the mid-1970s. But the Union Parishads did not manage to "arrange their budgets" in such a way as to pay their salaries. DPHE was therefore obliged to fill the breach. The cost of spare parts was recovered at standard list price from the caretakers by the tubewell attendants.

An evaluation of the new scheme at the end of 1978 showed that the rate of pump breakdown remained at 20 per cent - the same as before. The good part was that caretakers had accepted charges for spares without demur and that the number of spares issued by DPHE had significantly decreased. A survey revealed that less than half the repairs to public handpumps used DPHE spares and that caretakers undertook one-third of all repairs without assistance from the authorities: handpump users were willing to pay for spares and repairs and many were already doing so.

The caretakers had taken on the maintenance role assigned to the tubewell attendants without remuneration or back-up from the authorities. "Community participation" in handpump maintenance was already in place.

The caretaker's maintenance role was formally recognized in 1978. At UNICEF initiative and expense, brief training programmes in pump maintenance and repair were introduced, to train 200,000 handpump caretakers by 1980. The programmes were conducted by the local DPHE staff at the thana level. If the caretaker failed to attend, he did not receive the tools of his new trade - two composite wrenches specially designed by UNICEF - or the illustrated maintenance manual. The wrenches were valuable, and their possession was prized.

In the process of shifting the programme's centre of gravity towards the community and relaxing some of the reins of technical and managerial control, the handpump caretaker was beginning to emerge as the pivotal figure. But the process still had a long way to go. How much technical and social control should the caretaker be allowed to enjoy? These were questions for the future.

Linking water to sanitation and health

In the mid-1970s, evidence began to accumulate that the dramatic rate of tubewell installation was not bringing about any marked improvement in health. The rate of diarrhoeal disease among children had not dropped significantly, nor had Bangladesh seen the last of cholera and typhoid, as had been so confidently expected.

Various surveys on diarrhoeal disease and water usage were beginning to paint a complex picture of their relationship. The whole environment with its mix of elements, pure and impure, interacted with children's health and it was proving difficult to disentangle any one thread from the compounded skein. Drinking clean tubewell water interrupted one route taken by pathogens into the body, but it did not interfere with others whose importance now began to seem proportionately greater. The hazards associated with dirt had been neglected in the hope that the public water supply would wash it conveniently away. It had not. Finally, attention had to be paid to dirt, especially noisome human dirt, and the damage it was doing to children's well-being.

Growing demand for the water-seal latrine

In the early 1960s, UNICEF and WHO had introduced into Bangladesh from Thailand a type of latrine particularly suited to a water-abundant environment. The bowl was like that of a conventional lavatory pan with a U-bend water seal at the base. Upside down, the pan and its U-bend looked like a large bird; the seal was therefore known as the "goose-neck".

When flushed by means of a bucket of water thrown down the pan, the goose-neck refills and the water left there provides a barrier between disposed waste and the open air. This means that, if kept clean, the water-seal latrine can be as odourless as a standard water closet. However, since the water has to be fetched for flushing, the latrine has to be situated near a convenient year-round source. In Bangladesh, this is usually possible because of the ubiquitous presence of village ponds.

The first WHO/UNICEF-assisted village sanitation project began in 1962. The simplest and cheapest version of a water-seal latrine was promoted: a dug pit about five feet deep with a pan and slab directly over it. Latrine production centres were opened and 160,000 slabs with pans were issued free to householders, who were expected to dig the pit, line its walls and erect a simple superstructure on top.

In 1972-73, an evaluation found that less than a third of the latrines were in use. In most cases, the pit had never been lined and in the soft, rain-soaked soils, the walls had collapsed. Those latrines that were in use were almost universally damaged. People

had not understood how the water seal worked and had broken the goose-neck. As a result, waste descended straight into the pit and smells and flies ascended from it.

In 1975, a new sanitation scheme for rural areas was set in motion. This time the water-seal pan and slab were given away with five concrete rings for pit lining. The target was to install 280,000 household latrines and 700 units for schools and health centres, but the results were poor, with only 8,000 household and 75 school latrines being constructed in a four-year period.

Still, the acuteness of the sanitation problem and the prevalence of excreta-related disease induced a continued search for a winning formula. In time, it was found via a simple adjustment in packaging: the addition of a price tag.

Against much resistance from those who felt that where people were poor, they could not be persuaded to spend money on sanitation, a very limited experiment was made with marketing the latrine package for sale instead of distributing it free. A slab and a set of rings were sold for Taka 50 (US$1.50), a heavily subsidized price. When results were compared, it was clear that more latrines were both made and installed in areas where the package was sold instead of given away. Similarly, the standards of pit and cabin construction and the numbers of undamaged goose-necks were higher and a much higher proportion - 60 per cent - were in use. It seemed after all that there was some demand for the sanitary latrine that could be expanded. Although the total output of the selling centres was only 3,300 units in a year, this was the first encouraging sign that a latrine had a future as a household item.

1) Expanding production capability

In July 1978, a new village sanitation project was launched, in which 100 latrine centres were set up at the thana level. The target was to produce and sell 100,000 latrines over two years. Rural sanitation became a fully recognized element of DPHE's regular programme and a major training exercise was undertaken for staff at all levels. Local masons were trained in the production of water-seal latrines and then employed at the thana sanitation centres on a daily basis. A new subsidized price of Taka 100 was set to enable the programme to recover some of its costs. Since this was prohibitive for many rural households, experiments began with cheaper materials and alternative designs.

The launch of the revised programme for village sanitation marked the turning-point for sanitation prospects in Bangladesh. Within five years, the number of thana production centres had grown from 40 to 257; their total output of latrines and slabs from 1978-82 was 135,000 units. This was still an infinitesimal number in view of the 10-12 million rural households without latrines, but given that virtually all were in use, 83 per cent with their goose-necks intact, it was a promising beginning.

The importance of the achievement was its demonstration value. The latrine was becoming a popular household item. In some thana production centres, there was a waiting list for one or two months because orders were outstripping the masons' capacity to meet them. With very little in the way of promotion, water-seal latrines had suddenly started selling themselves. In the bazaars in large population centres, latrine shops were springing up. Years of tinkering with materials, prices and production were paying off; product and market had found a fit.

2) Creating a financially self-supporting latrine programme

By 1982, rises in the price of materials meant that the price of a latrine package, still Taka 100, was being subsidized by 70 per cent. Since there was now a demand for the latrine, there was a strong argument for reducing the subsidy. If customers' payments went back into the programme, it could become financially self-supporting. As in the case of handpump maintenance, here was a situation where a revolving fund managed at community level was the logical financial management approach. At its current price, the water-seal latrine was an affordable lavatory for one-quarter of Bangladesh's population. This meant that it could still be sold to another 2.5 million households before saturating its market. The attraction of raising the price to those who could afford it was that the surplus could be used to subsidize latrine prices for those lower down on the socio-economic ladder.

In the programme's next phase, from 1982-85, the price of a latrine bowl-and-slab and five concrete rings was conservatively raised to Taka 150. But instead of the customer's money being paid back into the project, the income went to the Government's revenue account. Since half the costs were met by UNICEF, this left the programme dependent on Government funds for the other 50 per cent. Instead of becoming self-sustaining, it remained vulnerable to perennial budgetary shortfalls. In a difficult year, enough Government funds might not be available to keep the latrine production centres functioning. A year or two later, this was precisely what happened.

Health education: The poor relation

From the mid-1970s onwards, the lack of progress in educating people about the connections between water, cleanliness and health became a constant theme in all surveys and assessments concerning the rural water supply and sanitation programme in Bangladesh. Despite the consistency with which the same ground was covered in every report, health education remained the weakest component in the programme throughout the late 1970s and beyond.

In its early years, the need for an effective programme of health education - although incorporated in the programme's plans of action - was not fully appreciated by its managers and implemen-

tors. Perfecting the technological hardware package for both water and sanitation, developing the machinery to deliver it to the community and making sure that handpumps did not fall into disrepair were far more pressing preoccupations.

There was an inherent logic in this attitude. If the tubewell was not installed or if service delivery was not dependable, there was no point in exhorting people to drink or wash themselves exclusively in tubewell water. The same reasoning applied to sanitation.

It was never quite clear who was supposed to undertake health education. The reputation of the DPHE was based on engineering, not educational prowess. While DPHE had a Health Education unit, even by the end of the decade this consisted of only nine officers among 4,000-odd staff. The Ministry of Health, which by 1980 had 33 different categories of health workers, gave a lower priority to health education for water use and sanitation. The Thana Health and Family Planning Officer was a statutory member of the Thana Water Supply and Sanitation Committee, but in effect there was almost no co-operation between medical and engineering services. The upshot was that the task was left to the health education staff of DPHE, who were able to do little beyond producing a few films and pamphlets for national distribution.

Yet health education was slated to emerge as a strategic factor in the making or breaking of the programme. As experience in Bangladesh amply demonstrated, it was an error to assume that the mere availability of a bacteria-free water supply or sanitary waste disposal mechanism would "fix" water- and sanitation-related diseases and improve public and child health. Much more was evidently required to persuade the users of the health safety networks to sharpen their perception of the link between clean water and sanitation and improved health. The programme's managers, likewise, had to see that whereas safe water and sanitation are inextricable from health, the connection between them is not mechanical but behavioural. It cannot become functional unless the beneficiaries themselves make it so.

Women as key role players

Bangladesh by the late 1970s was beginning to recognize that a very important impediment to the spread of understanding about the links between water, dirt and health lay in the exclusion of women from health improvement strategies. A 1978 study of the programme prepared for the WHO/UNICEF Joint Committee on Health Policy pointed out that women in Bangladesh were responsible for everything to do with the use of water and disposal of waste in and around the household; yet paradoxically, they played no role at all in the rural water supply and sanitation programme.

The study pointed out that women were responsible for fetching the water (often before dawn, when as few people as possible could see them), storing water in the household, cleaning water pots and utensils and organizing the use of water for cooking, cleaning, bathing and drinking. Since the DPHE programme tubewells were often sunk in public places, women were not disposed to linger at

the pump to wash or do their laundry. The study also observed that women, in passing on their own beliefs and practices, were the key influence over their children's use of water and their defecation habits.

There was reason to believe that the existing capacity of the tubewells was far from being fully utilized, especially in the wet season. While tubewell water was growing in popularity for drinking purposes, only about half the people drank tubewell water exclusively. A far smaller proportion used it for laundry, cooking and bathing.

A 1978 DANIDA evaluation pointed out that, apart from lack of health and hygiene awareness, factors more deeply associated with poverty might be inhibiting women from increasing their use of tubewell water. In the early 1980s, a further series of DANIDA-funded studies examined access to wells, water use and health awareness in an effort to prepare the way for an overhaul of programme strategies and to push for an increase in water utilization and a measurable impact on health.

Given that the vast majority of women were confined to the home, it was not easy to reach them, much less to identify ways of bringing them into programme activities. Men from other households, including health educators, were not expected to see or talk to women in a traditional household. The handpump caretaker was not likely to pass on information systematically to the women in his own compound, let alone his own village. Men only talked to their wives in private. By the same token, women who did have the education to become health issue communicators would be frowned upon, especially outside their own immediate neighbourhood.

The only obvious avenue for bringing women into the water supply and sanitation programme was through the handpump caretaker training programme. During the late 1970s and early 1980s, around 155,000 handpump caretakers were trained. Among these were a small number of women, leaders of women's co-operatives that had received tubewells under an extension of the DPHE programme to non-governmental organizations (NGOs).

In 1983, a survey of handpump caretakers was carried out. Although there were not enough women caretakers to make a proper comparison, there was evidence to suggest that women were better caretakers than men. They reported breakdowns more quickly, they were more inclined to keep the platform clean and free of debris and their ability to dismantle the pump and understand its technical workings was no different from that of men. The conclusion was that women, as the tubewell's direct beneficiaries, were more motivated.

Since the regular DPHE programme application form automatically designated the "Head of Community" as the handpump caretaker, women, by definition, were virtually excluded from consideration. To offset this, a new element was introduced into the caretaker training programme in 1985. Caretakers were asked to bring one woman from their household to attend the training course with them. Basic health-related messages were also incorporated into the course, emphasizing the use of handpump water for all domestic purposes, including hand washing.

Increasing community outreach in the 1980s

At the beginning of the Water Decade in 1980, the Bangladesh rural drinking water supply programme was moving steadily towards the target of "Water for All". Within less than 10 years, a system capable of delivering between 20,000 and 30,000 new handpump tubewells a year to village communities and keeping hundreds of thousands of others in working order, had been established. The machinery of programme delivery functioned reasonably smoothly.

A new programme coverage target was now set: one tubewell per 150 people. Because of the high population growth rate in Bangladesh, maintaining the existing coverage level (220 people per tubewell in 1980) required the sinking of 10,000 new tubewells each year. In addition, 2.5 per cent of existing tubewells needed either resinking or replacement each year. To reach any new target, particularly to do so equitably, required both an expansion of the physical machinery - personnel and hardware - and some tinkering with its operation.

One ready-made opportunity for expansion was to add tubewell sinking and latrine installation to the activities of existing basic services programmes. This had already begun in the post-1976 phase, with the installation of 15,000 tubewells in small towns and slum areas and of 7,500 tubewells in primary school compounds. Partnerships between the drinking water and sanitation programme and primary health care (PHC) programmes run by other Ministries expanded during subsequent years.

Partnership with NGOs

The 1970's saw a proliferation of voluntary activity in Bangladesh. The cyclone of 1970 and the independence struggle both tapped a rich vein of international and national compassion, causing a great number of voluntary organizations to begin working in Bangladesh. The resources they mobilized helped underwrite a major expansion of community development activity outside the framework of Government services.

Whatever kinds of projects motivated their original involvement - emergency feeding, flood shelter, health care, women's income-generation, school gardens - these voluntary groups soon discovered that a safe and reliable water supply was often essential for any long-term community gain. However, since their activities were privately organized and funded, they could not receive tubewells under the DPHE programme. UNICEF therefore found itself under constant entreaty from NGOs for tubewell materials. Starting in 1976, a special yearly allocation was put aside by UNICEF to cover the costs of materials for 2,350 NGO handpump tubewells.

The relationship between DPHE, UNICEF and the NGOs gradually took on more significance. Enjoying a much closer contact with the people among whom they were working, NGOs were able to structure their assistance to outflank existing centres of influence. The benefits of tubewells or other installations thus were more likely to be distributed through NGOs in such a way that they not only reached, but favoured the poor.

During the 1980s, the number of NGOs that took up tubewells to underpin other income-generating and health-related schemes grew steadily. An impressive example of collaboration with a private organization is provided by the Grameen Bank - an institution set up to improve the standard of living of Bangladesh's poorest group, the rural landless.

A private organization, the Grameen Bank offers collateral-free assistance to Bangladesh's rural poor for productive enterprises such as rice husking, dairy cow fattening and poultry raising. The Bank's members save in groups linked into a network. Extension staff are utilized to train the groups not only in concepts of banking and credit, but in literacy, home economics and primary health care.

In 1985, the Grameen Bank set up a rural drinking water supply programme, offering tubewells to members on a sale or part loan basis. Materials for 5,000 tubewells were supplied by UNICEF. Although the arrangement means that UNICEF is assisting the installation of privately owned tubewells, as opposed to the public service provided by DPHE, it paradoxically offers a more direct line to the most disadvantaged members of society. Over 75 per cent of Grameen Bank members are women, and all are landless.

Under the agreement with the Grameen Bank, tubewell materials were made available from local DPHE stores where the Bank had branches and the money raised by their sale was recycled through a revolving fund. These materials therefore constituted start-up capital for the Bank's water supply scheme, which, thereafter, would be self-sustaining.

By the end of 1987, there had been over 1,500 applications for wells from Grameen Bank members. Over two-thirds of the applicants were landless women, sometimes applying as a group but more often as individuals. They have each paid around Taka 1,500 for their tubewell and can afford this upgrading of domestic facilities because they have already improved their financial situation on the basis of previous loans. Because the pumps are in private ownership, many are located inside people's compounds; but Bank members usually allow free access to neighbours, especially those in their group.

In 1986, UNICEF also began to invite NGOs to accept support for setting up Village Sanitation Centres. A typical centre is often located in the heart of a rural area, closer to customers motivated to purchase latrines than a centre based at DPHE upazila (thana) headquarters. NGO masons are given UNICEF-funded training to make the standard water-seal latrine and UNICEF supplies enough materials for the fabrication of 50 complete latrine sets as start-up capital.

NGOs often offer a mix, linking improvement in such areas as health, adult literacy and women's self-betterment with small-scale economic production schemes. This affords the benefit of being able to use one type of intervention as an entry-point for another: pisciculture for nutrition, water and sanitation for health, latrine construction for income-generation. Under NGO management, services do actually mesh and intertwine in multisectorial fashion. NGOs also tend to develop approaches that are within their beneficiaries' means. For example, in the Bangladesh programme, NGO sanitation centres have made commited efforts to provide a range of cheaper latrines than the water-seal model offered by the Government, thus making them affordable to the poorest families.

NGO operations have grown to a level where today they are an accepted feature of the administrative landscape. They provide an alternative opportunity of public service for motivated and educated young men and women and an established channel for external support to community self-help. Because of the special character that places them somewhere in between the public and the private sectors, NGO partners are of great importance in helping to reach the twin goals of universal water and sanitation coverage towards "Health for All".

Towards consumer control

An important feature of programme evolution in the 1980s was the gradual takeover of the DPHE shallow well sinking and resinking programme by community self-help. When the system of community contribution was first introduced in 1976, it was envisaged that the 50 per cent share could in time be increased to 75 or 100 per cent. In 1979 came the first suggestion that tubewell applicant groups should assume a larger share of the costs and construction responsibility.

This suggestion evoked some reservations from Government authorities. Existing community contributions so far were remitted into the Government revenue account, which meant that the Government was recovering money from the programme. DPHE felt that the caretakers would not be able to handle things adequately and that the quality of construction would suffer. Moreover, they felt that only the better-off would have the organizational or financial wherewithal to apply for tubewells. The poorer people, DPHE argued, would be left out of the picture and service distribution skewed against them. DPHE did, however, agree that the proportion of costs paid by the community should rise to 75 per cent.

Although DPHE continued to resist the idea of a self-help tubewell sinking scheme, such a system was introduced in 1980 for resinking choked-up tubewells. Up to this point, the procedure for resinking was the same as that for new tubewells: application by a user group, DPHE to engage a contractor, the beneficiaries to meet half the costs. Since the costs of removing the old pipes from the ground had to be included, this procedure was more expensive than simply sinking a new well. Consequently, very few applications were made.

A different approach was therefore tried. Users of a choked-up tubewell themselves organized the removal of the pipes, screen and handpump from the well, collected whatever new materials were needed from the DPHE stores and paid a local mistri to undertake the repair work. This self-help system for resinking was a definite improvement. Many user groups went ahead and resunk their wells.

Between 1981 and 1983, 20,000 tubewells were resunk by self-help groups, almost none by contractors. A survey undertaken to test the quality of the work showed that the majority of wells had been resunk within a month of application using much of the original material. Many of the wells were resunk in their original location. Everyone appeared to gain from the system: it was cheaper to the users, it led to no noticeable drop in standards of work and it saved materials and Government expense. The only obvious losers were the contractors previously employed to do the work by DPHE. In 1983, the entire resinking programme was turned over to self-help.

It was logical to contend that if there were savings all around to be made by resinking tubewells through self-help, the same applied to the installation of tubewells. But DPHE continued to resist the latter on grounds that leaving the organizational responsibility to the communities would negatively affect workmanship and the rate of successful wells. UNICEF subscribed to the view that these circumstances no longer applied. During the previous 10 years, systems and procedures had been carefully developed to ensure that power could be devolved without loss of standards, technical or ethical. They included the tubewell application and site selection procedures; the establishment of water supply and sanitation committees at thana (later upazila) level; a hydrogeological book which defined for every Union the depth to which tubewells were required to be sunk; a tubewell register; the caretaker training programme; and guidelines and specifications for every kind of installation. As a result of extensive training and orientation, most of these procedures were well known throughout the water supply and sanitation hierarchy.

1) Sinking tubewells by self-help

In 1984, a familiar predicament forced DPHE to reconsider the proposition of shifting more financial and managerial responsibility for tubewell construction into the community. Budgetary cutbacks meant that DPHE had resources for sinking only half the number of tubewells - 20,000 - planned for installation during the coming year. Introducing tubewell sinking by self-help would allow the programme to pay for itself. DPHE therefore issued a guideline for sinking 10,000 tubewells by self-help.

The usual application procedure and site selection criteria remained in force. After site selection and approval, it was up to the community to collect the tubewell sinking materials from the local DPHE stores, hire a qualified mistri and proceed. Under an engineer's supervision, DPHE mechanics were expected to oversee

the sinking of each well, check its depth and water quantity and quality, enter the statistics in the tubewell register and ensure the return of unused materials.

There was no marked drop in the demand for tubewells in spite of the share of managerial responsibility now shouldered by the community. This presented a sharp contrast to the results of the Dhamrai experiment of 1974, which was an indication of how far things had progressed in 10 years. The disappointing feature was that, unlike the tubewell resinking programme, savings were not substantial. Most of the tubewells were, in fact, sunk at a slightly higher cost than under the conventional system. Also, more than half the caretakers failed to negotiate a similar service from the mistris at prices lower than those charged by contractors.

A positive aspect was the higher degree of involvement by families other than those of the caretaker. There was a wider spread of financial contribution and greater involvement in site selection by families whose names were on the application form. As a result, a much higher proportion of the tubewells (nearly 90 per cent) met the site selection criteria than did those sunk under the conventional system (75 per cent).

The caretakers were at the nub of the self-help system, unlike the days of the Basic Democrats and the Dhamrai experiment. While not all caretakers wanted to shoulder the organizational responsibilities, preferring to employ a contractor or let the Union Chairman or DPHE official act on their behalf, they did not otherwise object to the scheme. The cost to the community of installing a public service tubewell still compared favourably to its cost on the private market: Taka 500-1,000, compared to Taka 1,500-2,500.

In 1985, following a review, the entire shallow well sinking programme went over to the self-help system. Although there were some indications of loss of quality - the most worrying trend was the number of beneficiary groups that lost interest before they had completed construction of the platform - the overall standard of the sinking programme was not radically different. Inadequate supervision by the DPHE was identified as a major cause for the observed drop in quality. The shift to self-help removed the shallow well programme from dependence on Government budgetary allocations. A side-benefit was the opportunity for DPHE to direct more resources to under-served areas. One of these was the coastal belt, where the population ratio per deep tubewell was as high as 600 compared to less than 100 in many shallow well areas.

2) Self-help in maintenance

If the self-help system for sinking and resinking shallow tubewells was put in place by deliberate design, the concept of self-help in maintenance has still not been formally accepted. Over a period of 15 years, several carefully conducted trial schemes have established that user groups are willing to pay for handpump spare parts and help meet the costs of maintenance. The formalization of the role of the handpump caretakers has made a community-based

system practicable. No one any longer calls for a cadre of tubewell attendants employed by the Union Parishads, the proposed approach of the early 1970s. Village-level operation and maintenance (VLOM) is within easy reach in Bangladesh and is the effective operational system in many cases.

Since the mid-1980s, no serious shortage of spares has been reported. The number of pumps out of action has similarly seen no dramatic rise. This is a very altered state of affairs from the days of 1972, when maintenance was the leading issue in the rural water supply programme, when handpump repair was utterly dependent on departmental input and when the priority action taken by UNICEF was to import vast quantities of valves and cup seals. Nowadays they are available, locally made and affordable and hundreds of thousands of men and women know how to install them. Justifiably, UNICEF has begun to conclude that there may be no further need for its involvement in maintenance. VLOM, still a dream elsewhere, has become a reality in much of Bangladesh.

3) Devolving management into the community

So, in addition to the technocrat and the political policy-maker, a third force, the community, has now emerged as an operative factor in Bangladesh's water and sanitation development programme. User groups and caretakers, by their financial contribution and their knowledge of how things are supposed to be done, have become an integral part of the programme's sustainability.

Some continue to maintain that having "heads of community" serve as caretakers biases the programme in favour of the better-off. To ensure that the community obtains efficient and equitable service from the delivery system requires a process of delicate fine-tuning of responsibilities and an evolution to the point where the caretaker becomes the equivalent of the chairman of a consumer group.

This, in turn, requires that more knowledge about water and dirt as sources of disease is disseminated within the user group, poor and rich alike. The existing demand for tubewell water or sanitation cannot be transformed into better health unless users fully understand the health-protective applications of these amenities and implement them accordingly. By the mid-1980s, a strategy for meeting this challenge was already beginning to emerge.

The changing technological challenge of the 1980s

Although the design of the basic hardware package for the water supply programme was essentially complete by the mid-1970s, certain improvements continued to be made as a result of R&D initiatives.

One was the development of a new type of PVC well screen, a perforated pipe that acts as a sieve to trap sand while allowing the free passage of water. World Bank consultants Ron Sternberg and Bob Knight developed a technique for making low-cost "Robo" screens by cutting continuous spiral slots only 0.2 mm wide in PVC piping. The Robo screen was both strong and efficient. Moreover, it could be locally produced.

In 1980, UNICEF began to do just that, working in conjunction with the student engineers of the Mirpur Agricultural Workshop and Training School (MAWTS), an independent non-governmental institution. The screen was extensively field-tested in the early 1980s and by 1985, MAWTS was manufacturing 10,000 metres of piping a year. The Robo screen has entirely replaced the less efficient and more expensive imported well screen in the Bangladesh programme and has generated interest among water supply programmes in other Asian countries, notably Viet Nam.

Inventing a new "deep-set" handpump

The other important technological development of the 1980s, also undertaken in co-operation with MAWTS, was the invention of a new "deep-set" handpump for those regions in Bangladesh where the water table is below the seven metre suction level and therefore, beyond the reach of the No. 6 handpump. For many years, the deep-set mechanism most commonly used was to attach an India Mark II handpump to a No. 6 pumphead.

However, the India Mark II pump cylinder was designed for bringing water up from considerably lower depths than the 8-to-12 metres typical for the relevant areas in Bangladesh. Its use was a case of expensive technological overkill. Installation was complicated and costly. In 1979, a WHO consultant estimated that the cost of installing the requisite number of deep-set pumps to reach full water supply coverage, given current population growth trends, could reach US$1,300 million (US$1.3 billion): an impossible proposition.

In addition, the India Mark II was not a VLOM handpump and if washers or valves needed repair, it required a heavy and time-consuming operation to remove the cylinder from the bottom of the well. At full coverage, the annual maintenance cost would have been around US$70 million a year. This compared to an annual expenditure by UNICEF on new facilities of around US$10 million. A new solution with a more modest price tag was needed.

During the late 1970s, hydrogeological conditions in Bangladesh began to change. The drive for agricultural self-sufficiency led to intensive extraction of groundwater by power-driven pumps for irrigation purposes, especially in the dry season. The water table began to drop, descending below the suction limit at least for a part of the year in several areas where the No. 6 had been in use year-round. By the early 1980s, the trend had become much more marked with the annual drop reaching half a metre in some areas.

The need for a suitable deep-set handpump was becoming more acute. Surveys showed that sand clogging and maintenance difficulties were knocking up to 40 per cent of the existing deep-set pumps out of action at any one time. The DPHE began to tinker with the India Mark II, but it was clear that something better suited to Bangladesh's needs was required.

The World Bank, UNICEF and MAWTS began a test programme. Before long, they came up with a promising direct action pump design. In 1982, UNICEF and the Bank entered into a partnership with MAWTS to develop the pump for Bangladesh. Design criteria were established. The pump should be simple to manufacture suitable for local production and as many as possible of its components should be available off the shelf. It should also be easy to maintain. Its bearing and wearing surfaces had to be kept to the minimum so that villagers could manage to dismantle the pump rod and do whatever was necessary to make repairs themselves without recourse to hand tools or sophisticated instruction. The pump also had to be compatible with the sludger method of well sinking, without the need for casing and other construction complications that would require the involvement of contractors and push up the price for the users.

The first prototype of what came to be called the "Tara" pump was produced by the MAWTS workshop in 1982. (Tara, a name coined by one of the key developers, means "star" in both Bangla and Hindi and "tara-taree" in Bangla means "quickly".) Successive versions of the Tara were developed over the next three years by a process of trial and error.

The first 12 pumps were tested in 1983. At this stage, UNICEF withdrew its support from the continuing DPHE effort to adapt the India Mark II and invited it to join in the development of the new pump. During 1984 and 1985, 200 Taras were field-tested by DPHE and another 130 by the World Bank in Mirzapur, an area where the International Centre for Diarrhoeal Disease Research (Bangladesh) was carrying out an intensive health education research project. All the pumps were manufactured in the MAWTS workshops. MAWTS also trained DPHE engineers from field test areas as well as UNICEF works inspectors.

UNICEF underwrote the entire developmental phase of the Tara programme, from production, testing, training and installation to monitoring and maintenance, so that it could thoroughly review every detail of Tara technology and establish management and logistics on a firm footing for the much expanded deep-set tubewell programme of the future.

Mass production and deployment of the Tara pump

By 1986, 15 per cent of the country was suffering from serious seasonal depression of the water table. It now became important to speed up the development of the Tara pump to the point where it could go into mass production. With around 15 million people in the target population user group and only 6,000 deep-set pumps

installed, the existing coverage rate was close to crisis: one pump per 1,500 people. This compared with a target user group of 140 for shallow well areas.

The Tara pump finally moved beyond the demonstration and pilot phase in 1987. Orders for 50 pumps each were placed with eight production companies, six of which - including MAWTS - manufactured the pump to the specified standard. These pumps were then supplied to the DPHE programme and installed in 60 upazilas around the country. To allow for continuing R&D, the rising main and pump assembly were housed in an extra wide (three-inch) upper-well casing so that the complete pump could be removed for inspection, or, should the final design be modified, for replacement. New users of the Tara, asked in late 1987 what they thought of the pump, were enthusiastic.

During the next five years, 60,000 Tara pumps and tubewells are scheduled for installation. DPHE engineers are being fully trained in Tara technology, pump specifications have been finalized, orders placed and inspection agents retained. During the present introductory phase, the flat rate for the community contribution to installation of the pump has been fixed at a modest Taka 350 (US$11.50). Caretaker training has also begun.

The next stage is to develop a Tara II, a deep-set handpump suitable for water table depths of up to 30 metres, a level to which it is likely to sink in some areas in the dry season if the current rate of groundwater extraction continues.

Already, the private market in deep-set areas is carrying Tara handpump spares and some Tara caretakers are organizing repairs on their own. The international market very quickly began to come up with its own versions. The manufacture of pipes, pumps and screens ensures that many Bangladeshi artisans make a respectable

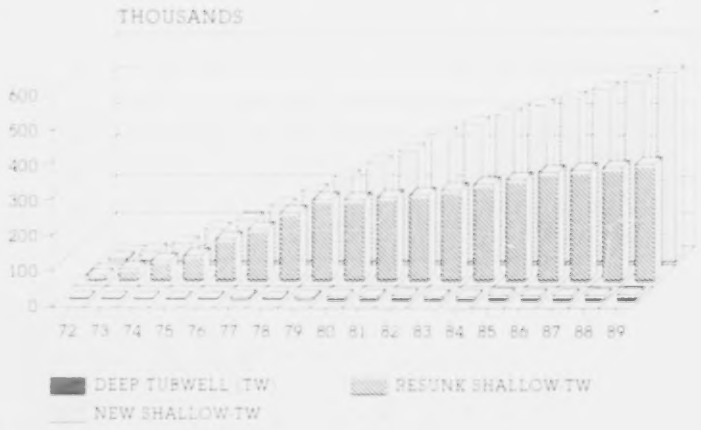


Fig. 2: RWSS Programme - Bangladesh
Cumulative physical outputs - water

living. Those who make and sell them, as well as the families of those who buy them, can look forward to a brighter future.

Between 1972 and mid-1985, the rural drinking water programme sank 408,000 shallow tubewells, 9,000 deep tubewells and 6,000 deep-set tubewells; beginning 1976, its sanitation arm had produced and sold 360,000 water-seal latrines. The tubewell-to-user ratio had been reduced from one per 325 persons to one per 160 and, assuming a latrine user rate of six people per unit, human waste disposal facilities had been made available to 2.5 per cent of Bangladesh's rural population.

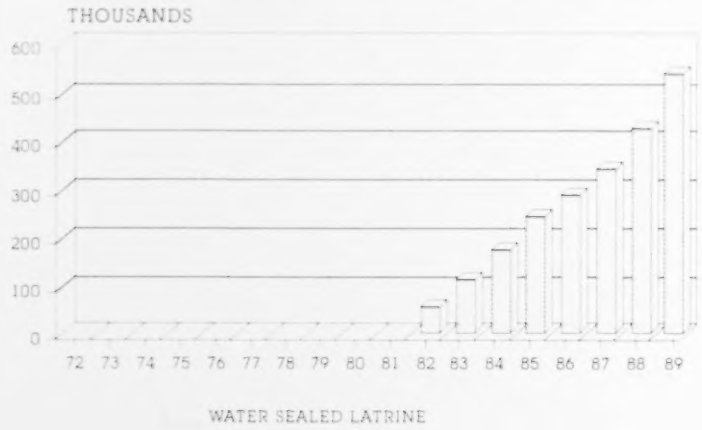


Fig. 3: RWSS Programme - Bangladesh
Cumulative physical output - latrines

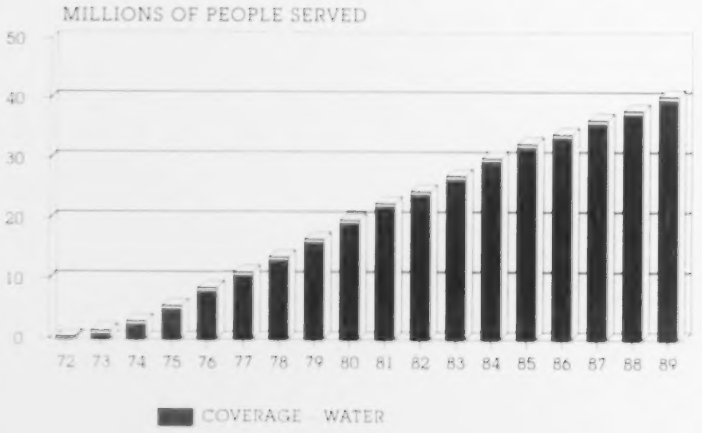


Fig. 4: RWSS Programme - Bangladesh
Cumulative service coverage - water

Broadening the health impact

During the first half of the 1980s, a much more detailed picture began to emerge about the nature of the relationship between water, waste and people in Bangladesh. Various R&D activities were coming to terms scientifically with the influence of behaviour patterns on germ-associated disease. Socio-economic information began to be placed on a par with technical data in the effort to understand the dynamics of water supply, sanitation and health. During this time, the International Centre of Diarrhoeal Disease Research was analyzing the transmission paths of infection, while from 1983 to 1985 DANIDA carried out its series of socio-economic studies into water supply and sanitation usage.

DANIDA-sponsored studies laid the groundwork for a new approach designed to realize the programme's potential health impact. An important finding was that neither the benefit of the services nor an appreciation of their health-related value reached deeply into the user group. Unless the programme was structured differently, its benefits would accrue disproportionately to the better-off. Only the caretakers and their peers had enough money to afford a water-seal latrine, enough influence to site the tubewell conveniently near to their household, enough know-how to keep it running and enough education - perhaps - to appreciate the health advantages of using the new facilities.

The switch to upazila management and local control of the programme took place in 1985. Quality control visibly suffered in the first year from the loss of DPHE's technical and managerial authority. Corrective measures were introduced to improve tubewell site selection, enhance the promotion of latrines and develop stronger community awareness of the impact of unsafe water and sanitation on health.

In 1986, programme forms were modified or introduced in an effort to improve service delivery in favour of poorer users. The changes included: application forms for sinking shallow tubewells on a self-help basis; site checking forms for new shallow wells; new agreement papers to be signed between successful applicant groups and the authorities; completion report forms; and application forms for resinking choked-up tubewells. The new tubewell application form now required that listed families own no more than five acres and that at least half the applicant families (five out of ten) own less than one acre. Other procedural changes were intended to diminish the influence over tubewell locations exerted by the Union Parishad Chairmen.

Another important change introduced in the sanitation programme sought to benefit the poorer members of the community. By this stage, Village Sanitation Centres had been set up in each of the country's 460 upazilas. Demand had grown to the level of almost 100,000 water-seal units per year and still easily outstripped supply. The time had come to introduce changes in the pricing structure.

Beginning in 1986, the charge for a slab and five concrete rings for pit lining was raised from Taka 150 to Taka 250 (compared with a real cost of around Taka 400). The subsidy on the total price was reduced, but the slab itself remained heavily subsidized. Customers were now permitted to purchase just the slab, or the slab and a ring, costing Taka 50 and Taka 20, respectively; subsequent rings cost Taka 45 each. Those who could only afford the basic slab could line their pit with clay rings, woven bamboo or other local materials. Village Sanitation Centres began to offer latrine ware choices at different prices to suit different pockets.

The need to expand output and sales was acute. But the sanitation programme was still highly vulnerable to the Government's budgetary process. Then the 1986 budget was cut by more than three-quarters. In response, UNICEF proposed that revolving funds be set up in each upazila to channel income from latrine sales into the Village Sanitation Centres. The proposal was finally agreed to in 1987, the first time that a mechanism for cost recovery had been accepted for any part of the Bangladesh RWSS programme.

The integrated approach

Although the title rural drinking water supply and sanitation programme suggested a co-ordinated service, in fact it offered two quite separate products - tubewells and latrines. The logical next step was to link the two together and connect both to the promotion of health and hygiene.

The "integrated approach" designed to effect this went into operation in December 1986 as a two-year trial in two upazilas in Chittagong district. The lynchpin of the strategy was that at least half the families in a successful tubewell applicant group would have to construct latrines before the tubewell construction materials were released. To encourage the group to construct latrines, as well as to make sure that they were properly made and properly used, an intensive programme of health education would be carried out.

Other important attributes of the integrated approach included the prolonged exposure between project personnel and tubewell applicant groups which, in itself, became a force for community action, allowing time for the reinforcement of health messages and behaviour changes. With the conventional procedure, the extent of contact between project staff and the user group is limited to contact with the handpump caretaker; his contact with the other tubewell users on the subject of the water supply is usually limited to dealing with complaints.

With the new approach, village-level health workers, including the local health officer (a statutory member of all water and sanitation committees), take part in health education activities with the user groups, themselves a ready-made audience for health messages and different programmes such as EPI and family planning.

Other personnel are also mobilized: teachers, village defence workers, social workers, staff from Union family welfare centres, NGO activists and volunteers. Every effort has been made to identify appropriate allies. Some are targets for information and health messages, others are resource people for training sessions and house-to-house visiting. Wherever a local NGO already has a mother's group and/or adult literacy class, an attempt is made to incorporate key messages about water, waste and health into their activities.

In promoting the tubewell and latrine combination, the tubewell mechanics play a key role. As the programme evolved, these stalwarts of the DPHE field team moved from repairing handpumps to supervising tubewell construction. Now they are taking on the role of health educators and latrine salesmen.

Once an application for a tubewell is successful, the first task of the tubewell mechanic is to help construct a demonstration latrine from materials provided by a member of the user group as a model for the others to follow. Then he follows up to inspect progress, agreeing to tubewell construction when the five latrines are finished.

Intensifying communication support

A key feature of the integrated approach in the two upazilas where it has so far been introduced is the intensive programme of communications activity. In this context, Chittagong district has become the laboratory for the entire programme nationwide. New forms developed for the programme, all incorporating health education messages, were tried out in this area. A whole new range of promotional literature and visual aids has also been produced, both for use in training programmes and among user groups. Messages on flyers, posters and leaflets are kept simple: "Use tubewell water for everything"; "Use a latrine"; "Wash hands after defecation and before handling food"; "Don't let your children waste nourishment on intestinal worms". Two seminars have been held for upazila Parishad members, 36 seminars for the Union Parishads and 12 seminars in schools, colleges and health institutions.

In the first year of operation, around half of the groups whose applications for tubewells were successful built their quotas of latrines: 50 out of 100 in one upazila and 24 out of 60 in the other. Altogether, the applicant families installed 455 latrines, of which slightly more than a third were of the water-seal variety.

Given the constraints and unfamiliarities of the new system, the first year's experience seemed to vindicate the strategy of linking tubewells to latrines. Convinced of its viability, the programme moved ahead into a second year, with a promotional campaign to increase the number of tubewell applicant groups.

Prognosis

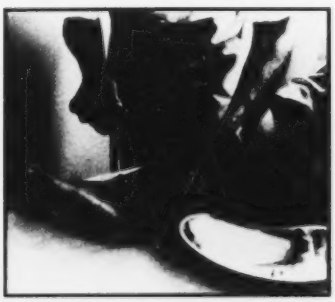
The DPHE and UNICEF staff involved are sufficiently confident of the results achieved so far that they will soon expand the programme to another six upazilas. It will take many years before the full impact of health benefits from the new approach shows up in district or national statistics, but if the programme's managers are right, the integration of tubewells with sanitation and health messages with both, will finally begin to unravel the knot that for so long has bound water with dirt and both with disease.

If, on the other hand, they are wrong, DPHE's planners and advisers will no doubt come up with another approach. Adaptation to new circumstances and information is the hallmark of the RWSS programme in Bangladesh. In 16 years, thanks to its capacity for adaptive change, the programme has moved from "crash" tubewell installation and emergency handpump repair to social mobilization and sanitation salesmanship.

Progress towards these targets has been consistently accompanied by efforts to broaden the programme's range and deepen its impact. A great variety of professional and scientific skills has been deployed in developing methodology and procedures. The inspiration for that continuing process has been the same inspiration that brought UNICEF into the picture in the first place: a transformation in the health of children in Bangladesh and a transformation in the quality of family life in one of the poorest rural environments in the world.

CASE STUDY II

INDIA



INDIA

A programme born of emergency relief

The development of a rural water supply and sanitation (RWSS) programme in India grew out of growing water scarcity in hard rock areas. The technological challenge of providing "problem villages" with a reliable borehole gave the programme its driving force. But a borehole is only as reliable a water source as the handpump that works it; and it is only as health-promoting a water source as the hygiene awareness of its users permits.

The Indian RWSS programme has addressed technological, managerial and community development issues with different degrees of urgency and success. The case history presented here traces the evolution of the programme in all three areas and examines the gap between the extraordinary degree of political support accorded RWS and the slow pace of health and sanitation impact.

In the early summer of 1967, in response to the drought-stricken plight of villagers in the states of Bihar and Uttar Pradesh, some of the first "down-the-hole" (DTH) hammer pneumatic drilling rigs for water borewells were introduced into India by relief agencies. Eleven of these Halco "Tiger" rigs were airlifted in by UNICEF. Within a few months, these rigs had pounded swiftly through soil and rock, bringing water to over 250 villages whose inhabitants had been threatened with imminent evacuation to drought refugee camps. Out of this emergency relief action grew a national programme which, within 20 years, has transformed the picture of rural water supplies throughout the Indian subcontinent.

Given the programme's origins, no one could have anticipated what was to become the largest investment in borehole and handpump technology for village water supplies ever made by any country. Some of the contributory factors are external to the programme's own dynamics; they include geological conditions, political ramifications, India's size and vast rural population, the scale of its financial resources and its existing industrial base.

During much of its history, the programme has also enjoyed the fullest backing from the very uppermost reaches of Government. The combination of circumstances, political good fortune and design has led to a programme that is a model for many other rural water supply schemes.

There are features in the Indian programme's evolution that are instructive because they indicate an impressive degree of symmetry between the obstacles encountered and the strategies employed for surmounting them.

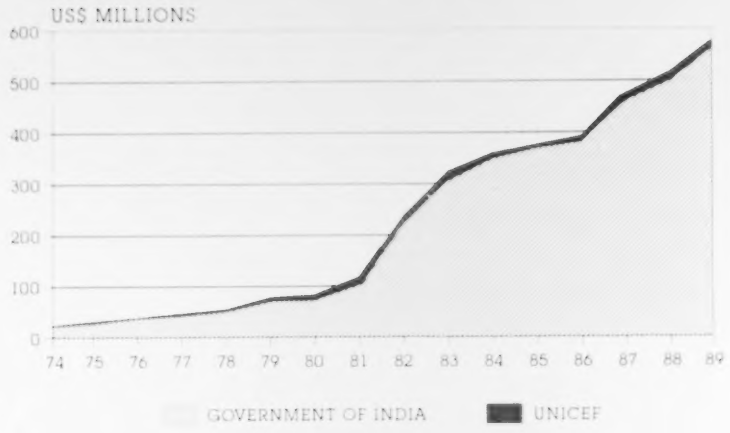


Fig. 5: Drinking Water Programme - India
Annual Government and UNICEF funding

If the Indian programme is exemplary worldwide, in terms of water supplies and in the dimension of appropriate technological solutions, it has also come under fire in recent years for its rigidity in pursuing installation targets and its less than adequate strategies for programme maintenance and sustainability. Despite professed intentions, the programme has failed, since its inception, to galvanize the same interest and support for sanitation and health education as it has for water. While no one can dispute that expanded water supplies have immeasurably upgraded the quality of life for women and children in India's "hard rock villages", as yet, the service, which is usually provided by a Public Health Engineering (PHE) Department, has no more than scratched the surface of poor hygiene, related infection and environmental cleanliness.

Since 1969, UNICEF has been a close collaborator in the Indian effort to bring clean domestic water supplies and improved environmental sanitation to the inhabitants of its 575,000 villages. How the programme has achieved its triumphs and how it has yet to live up to the challenges it must meet if it is to fulfill its potential for promoting child survival and health, are the subject of this case history.

The northern part of India below the Himalayan complex is a vast alluvial plain watered by three great rivers, the Indus, the Ganges and the Brahamaputra. The other 70 per cent of the country, the central and southern peninsular slab, consists of a rock shield giving way to softer sediments only at its coastal fringe.

Until the end of the 1960s, this hard rock terrain was classified as "technically difficult" for the provision of reliable water supplies. Much of it was drought-prone and disease-endemic. Rivers were seasonal, dwindling to streams in the dry season and in years of monsoon failure their recharge could not be guaranteed. The groundwater reservoir was limited and deep; and under increasing

environmental pressure, it was gradually dropping and depleting, vanishing into the hard rock and becoming progressively more inaccessible.

The traditional method of well construction was to dig down through the soil overburden and break into the rock shield by splitting it with fire and water. But as the water table dropped, these hand-dug and blasted wells became more difficult to implement and less reliable. Old-fashioned drilling methods, some of which wore down the rock by steel shot, were almost as painstakingly slow, sometimes boring through the rock at a rate of only a foot a day. Before the advent of the down-the-hole hammer driven by air compression, the best conventional engineering equipment was the percussion cable-tool rig, which ground down the rock at a rate of between three and ten feet a day. With 100 or 120 feet to go, it still took several weeks to produce one borehole. The new rigs could drill through this amount of rock in around eight hours.

The pioneering role of NGOs

The first rigs to be brought in were Halco Tigers - quite small machines capable of drilling a four-and-a-half-inch borehole to a depth of around 150 feet. The speed at which they produced a new well seemed little short of miraculous and they were a considerable success during the 1967 Bihar and Uttar Pradesh emergencies. However, for the next few years they were seen as tools for application in drought emergencies only. Once the drought was over, they were moved from Uttar Pradesh to Andhra Pradesh for use in another drought emergency. It took a few years before the full potential of the new hard rock technology was fully recognized.

One reason was that the early deployment of the high-speed rigs was not indigenous in its operational character, was initiated on a small scale and lay outside the context of regular developmental activity. The voluntary organizations that brought in the very earliest rigs were truly the pioneers in India of using this kind of equipment. The drill bits wore out constantly in the very hard crystalline formations and the supply and spare parts chain was non-existent. The initial users found themselves continuously resorting to extraordinary methods of back-up to keep the rigs operational.

To solve these problems, they set up a co-ordinating umbrella organization for NGOs involved in water-well drilling called AFPRO (Action for Food Production). This organization still exists and has played a continuing role in small-scale private-sector voluntary activity associated with water exploitation for domestic and agricultural use.

Bringing hard rock drilling to "problem villages"

For many years, the Central Public Health Environmental Engineering Organization (CPHEEO) and the State Public Health Engineering Departments or Water Boards had been engaged in the

provision of village water supplies for agricultural and domestic use. In 1962, the first survey to identify "problem villages" - a definition then used to describe water-scarce villages, later broadened to include other types of water problems - was set in motion by the Health Ministry.

This exercise established the basic strategy for India's rural water supply programme, a strategy which has remained essentially unaltered since. Criteria developed for identifying problem villages were then applied, district by district and state by state. The installation of water supplies to those villages became the target of the national rural water supply programme. However, during the 1960s, in the pre-high-speed drilling era, the authorities had no effective way of helping problem villages in the hard rock areas of the country. Altogether, 153,000 such villages were identified at this time, the majority in the hard rock areas.

In 1969, because of the dropping water table, the Indian authorities became more concerned with the ongoing problems of water shortage in "technically difficult" areas. They developed a plan for a rural water supply programme in these areas and as they had previously done in the Bihar emergency, they approached UNICEF for assistance in procuring the fastest, most up-to-date hard rock drilling equipment. Neither UNICEF nor the Indian authorities had ever embarked on a programme of this type or scale before. Therefore, UNICEF employed the services of a Swedish company (Atlas Copco) to conduct an inquiry into its feasibility by examining the hydrogeological, technical and administrative context in 10 of India's hard rock states.

The recommendation was that the programme should go ahead and that UNICEF should provide the 125 high-speed pneumatic rigs the Indian Government had requested. The rationale seemed conclusive: a crying need for water in drought-prone areas; the impact a reliable water supply would have on the quality and health of rural life; the presence of an adequate groundwater reservoir; and the existence of the technology for its rapid exploitation.

UNICEF showed its faith and willingness by investing US$5.9 million, then one of the largest amounts the organization had ever earmarked for capital equipment for a single, not to mention experimental, programme. But the decision turned out to be justified. It facilitated the full-scale introduction of hard rock drilling into India and it established the pre-eminent role of UNICEF as external support agency in the rural water supply programme.

The decision also set a pattern for future developments within the programme. The size, resources and organizational character of UNICEF fitted it to play a bridging role between the tiny, localized, tightly controlled, pioneering NGO operation and the subsequent incorporation of its approach into a statewide or nationwide endeavour, run by the regular, appropriate departments of state and central Government. This is a pattern that has recurrently emerged at different stages of the programme's evolution.

Programme management in the 1970s

The UNICEF decision to procure 85 "down-the-hole", or DTH, air hammer rigs for India was taken in 1970. The plan envisaged two types of DTH rigs, some capable of drilling four-and-a-half-inch diameter bores, others of six-and-half-inch diameter, mostly to depths of 150 feet but some as deep as 500 feet. Some conventional heavy cable-tool and rotary rigs of kinds not available in India were also purchased for drilling in the softer formations of the northern plains. At a drilling rate of around 100 boreholes per rig per year, this equipment was expected to provide a good-quality water supply for 12,000 villages in 11 states annually, covering the needs of around 9.2 million people.

The provision of this equipment brought the total number of rigs provided to India by UNICEF to 125, including Atlas Copco and Ingersoll Rand equipment. The rigs, together with support trucks and spare parts, were delivered to various states during 1970-74. Since most of the equipment was landed there, Bombay became the base for a stores and warehousing operation for spare parts and logistics back-up. UNICEF still maintains this operation.

At the central level, the responsibility for giving overall policy guidance to the state bodies in charge of water supply services lay with CPHEEO, which came under the authority of the Ministry of Health, Family Planning, Works, Housing and Urban Development. (By the Fifth Plan period, 1974-78, the Ministry of Health and Family Planning was established separately and the CPHEEO/Rural Water Supply Programme thereafter was placed under its aegis.)

The range of operations carried out by the state bodies included geological survey, well site location, drilling, water quality testing and equipping of the new boreholes with handpumps. These bodies were variously constituted and came under the authority of different state sectors; some were virtually autonomous. All needed to upgrade their technical and managerial competence to use the new rigs, whose speed had the potential of revolutionizing the progress of the programme if they were effectively deployed.

Organizational capacity building

The state level of activity was therefore identified in the 1970-74 programme as the main target for building capacity and human resources. The community level was not ignored, but was not similarly targeted. After the installation of a new borehole and handpump had been completed in any village, its operation and maintenance would become the responsibility of the gram panchayat (village council), the traditional custodian of community installations in rural India.

The Government and UNICEF, at this stage, placed the emphasis on the training of personnel: technical and administrative courses for supervisory staff and technical and practical courses for

drilling rig operators and crews. Much of the early training was carried out at the Rajasthan Ground Water Board training centre. UNICEF also added to its staff in Delhi engineering professionals with longstanding experience in well construction and air-hammer equipment to maintain contact with manufacturers and ensure the smooth procurement of spare parts for the rigs. This provided UNICEF with the capacity for ongoing evaluation of the equipment it had provided and a ready source of technical expertise for state bodies that requested it. WHO provided advice on appropriate training curricula and links were envisaged with other rural health, applied nutrition, educational and community development activities.

Although it was recognized that around 100 rigs could not transform the water shortage problems of more than a fraction of the 200,000 villages in hard rock areas, the hope was that the equipment and technical training of people to operate them would give each state a nucleus on which to base the programme. Even at this early stage, these were visions of a vast network of water supply services, with support from central and state governments as well as multilateral and bilateral donors other than UNICEF. The plans of operation called for a major evaluation of the programme in 1974, by which time it was assumed that the states would have readied themselves for major expansion.

Additional criteria for "problem villages"

By this time (1972) the Indian Government had completed its survey of rural water supply problem villages and the criteria had been more completely defined. Water scarcity was still the first consideration: any village more than one mile distant from or more than 50 feet above water was classified as "problem"; but for the first time, villages where cholera and dracunculiasis were endemic were also included, as well as villages whose water was unfit to drink because it contained excessive fluoride, chloride or iron, substances hazardous to health if consumed in too great a quantity.

The slating of 153,000 problem villages was accompanied by a commitment to provide a high proportion of these villages with water during the 1974-78 Fifth Five-Year Plan. That Plan elaborated a Minimum Needs Programme (MNP) for services in poor communities, including elementary education, slum improvement, housing, roads and drinking water supplies. The whole concept of a major national programme specifically designed to provide social services for the poorest and most underprivileged members of society was itself a landmark in national policy development. The MNP was to receive a four-year investment of US$4,285 million, indicating the Government's commitment to improving the health and living standards of the rural poor.

An emerging drilling industry

During 1970-74, the suitability of the new drilling technology proved itself beyond any serious doubt. The speed at which boreholes were drilled more than compensated for the additional capital and recurrent costs of the sophisticated rigs, making the price per borehole much more economic than the traditional methods. Some parts - drill hammers and bits - were beginning to be manufactured locally. A fledgling drilling equipment industry was developing, encouraged by the Government's increasing interest in boreholes and handpumps. During the Fifth Plan period, the Government intended to spend around US$600 million, or one-seventh of MNP allocations, on village drinking water supplies.

By 1974, the 125 UNICEF-supplied rigs formed the core of many states' hard rock drilling programmes. UNICEF planned to spend a further US$9.3 million on water supplies and sanitation during the new Plan period, as part of a comprehensive programme of assistance for meeting child-related "minimum needs". The lion's share would go, as before, into drilling equipment; but the input into this type of hardware was smaller and more selective. The new emphasis was on special purpose rigs, since it was felt that the country now had a nucleus of the standard four-and-a-half-inch rigs as well as a reasonable back-up and logistics system for their operation and could meet its requirements for this type of equipment within its own resources.

The first phase of an entirely new large-scale rural water supply venture was essentially complete. But along with some success, serious problems began to emerge from an unexpected direction.

Whereas the national rural water supply programme's emphasis has been on problem villages, UNICEF has focussed on the "problem areas" within the programme. Many of these surfaced as the programme advanced; others, such as almost inaccessible villages and difficult geological conditions, had always been there but were awaiting technological advance.

Advancing the technology: Handpump innovations

In 1974, a major problem threatened to ruin the entire programme. Spot surveys carried out by UNICEF in the states of Tamil Nadu and Maharashtra showed that, at any one time, around 75 per cent of the handpumps installed on the wells were out of action. The technical complications of drilling in India had eclipsed other issues. Now it appeared that a US$6 million plus investment in drilling had supplied close to 9,000 villages with little more than a hole in the ground.

It had been assumed that the gram panchayats would take the new water supply installations into village "ownership" and become responsible for maintenance and repair. But no comprehensive

system of spare parts provision to the village mistris (handymen) had been developed, nor had a training programme in maintenance. It was falsely assumed that since the pumps were familiar in the countryside, people not only knew how to repair them but would do so.

The key to the problem was the fact that the pumps being installed were cast-iron copies of old-style European and American homestead pumps, long obsolete in the land of their birth. Designed for use by a single household, they were not strong enough to stand sustained use by an entire Indian village community. They broke down repeatedly and the task of repairing them became overwhelming even where the expertise and spare parts existed.

The twin problems of the pump's fragility and the lack of a maintenance system were tackled simultaneously. The first concern was that a different handpump should be identified for use in the water supply programme, a handpump designed and built to remain in action without breakdown over long periods of time. The UNICEF water supply staff began the quest for such a pump by examining all the existing pumps in use in rural India.

The handpump problem was not new. The first organization to replace the old cast-iron pumps with something better was a private voluntary organization (the Church of Scotland mission) at Jalna in Maharashtra. During the late 1960s, what was known as the "Jalna" pump came into being, the brain-child of a self-taught Indian mechanic and driller. This was an all-steel handpump, its principle design improvements in the pump-head. Its single-pivot handle, with a sealed ball-bearing, was a great advance over the multi-pivot handle of the old cast-iron pump. Also, its connecting rods were kept in alignment and constant tension by means of a linked chain running over a quadrant, thus prolonging rod life. Several hundred of these handpumps were turned out by the mission workshop at Jalna over the next few years.

Another voluntary agency (also a church mission) at Wadala copied the Jalna pump and improved upon it. Known as the "Jalwad" pump, this was a better and more accurately fabricated pump than the Jalna. Most of the design effort continued to focus on rendering the above ground mechanism less subject to breakdown from heavy or careless use. In the early 1970s, the Sholapur Well Service (funded by the Swedish Covenant Church) came out with a better pivot design. The "Sholapur" pump was a considerable advance over its Jalna and Jalwad precursors because it was professionally designed and manufactured on jigs and fixtures, which ensured uniformity. By 1974, there were several thousand of these three types of pumps installed on wells all over Maharashtra by NGOs affiliated with a co-ordinating body called AFARM (Action for Agricultural Renewal in Maharashtra).

In 1975, UNICEF began to examine the different models and settled on the Sholapur pump as the interim solution. UNICEF purchased 5,000 Sholapur units and used them as conversion heads on existing cast-iron pedestals. Their performance was convincing.

This was how the Sholapur pump came to be used as the basis for a new pump, whose design criteria were set by a 1975 workshop on deep-well handpumps. Sponsored by UNICEF, WHO, the

Government of Karnataka State and the Government of India, the workshop was attended by representatives of state PHE departments. Subsequently, UNICEF took on the co-ordinating and facilitating role in the pump's development, working with MERADO (Mechanical Research and Development Organization), the AFARM affiliate and a Government-run engineering company (Richardson & Cruddas of Madras), which produced all the prototypes. From this joint endeavour emerged the India Mark II handpump.

The development of the India Mark II

Many of the India Mark II's key features were derived from the Sholapur. The extra design modifications needed were largely ones that would enable the pump to be easily mass produced and more easily maintained. The pump had to be manufacturable in simply equipped workshops from components available in India; its ex-factory cost had to be less than US$200; it had to be sturdy and safe, and had to function without breakdown for at least a year. Other new design elements were introduced for aesthetic or practical reasons: its pedestal base would fit over a casing pipe measuring five inches, which was by then the size commonly in use; the weight of the handle was increased by using a solid bar instead of a pipe to counterbalance the weight of the connecting rods and make pumping lighter.

Field testing of 12 pre-production India Mark II handpumps (manufactured by Richardson & Cruddas) was carried out in 1976 and 1977 in Coimbatore, a district of Tamil Nadu where the static water table was low (around 40 metres) and the rate of handpump usage was high. Various modifications to the design were made at the end of this period in preparation for the full production phase.

Production of the India Mark II started in earnest in 1977-78 and, to begin with, around 600 pumps were produced each month by Richardson & Cruddas. Very soon, steps were taken to develop manufacturing capacity in other states. It had been deliberately decided not to patent the Sholapur pump so that production could open up as fast as possible. But a careful balance had to be found. This entailed encouraging the growth of a new and popular engineering product for which sizeable state contracts would be forthcoming, while ensuring adequate production quality control to prevent cheap and shoddy imitations of the Mark II flooding the market, thereby making the standardization of parts impracticable.

The performance of the India Mark II pump turned out to be its own best advertisement. Although there was temporary resistance from some state Engineering Departments, the benefits of a pump that would lower the breakdown rate and raise the quality of the programme by a significant margin quickly overcame all scepticism. UNICEF put considerable energy into advocating the viability of India Mark II in the hard rock areas. An installation manual was produced and training offered to PHE staff in installation and

maintenance procedures. Within a short space of time, 10 key states were converted to the India Mark II: Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and West Bengal. In 1979, a National Conference on Deepwell Handpumps was held at Madurai in Tamil Nadu, under the sponsorship of the CPHEEO and UNICEF. Representatives from seven of the states attended and the conference recommendations moved the whole handpump programme in rural areas towards uniformity and standardization of the India Mark II.

The conference fully endorsed the need for the pre-qualification of suppliers and resolved that all states establish quality control procedures. But these recommendations were difficult to enforce. The very success of the Mark II began to threaten its downfall. Manufacturers turned out all kinds of versions of the pump with components and parts that were far from interchangeable. A way had to be found to ensure that all the careful investment in the pump's development was not thrown away. In time, the Indian Government adopted a system of pre-qualifying India Mark II manufacturers and of in-factory product inspection and the "pirate" manufacturers were eased out.

In 1980, the Indian Standards Institute issued the first full specification for the pump's manufacture. Meanwhile, through a process of vendor questionnaires to potential new manufacturers, factory inspections, technical assistance and trial orders, UNICEF undertook to identify a list of qualified manufacturers for the Mark II pump. By 1984, there were 36 companies on the list, at least one in all the states that had adopted the India Mark II for their RWS programme. Meantime, production capacity throughout India had already reached well over 100,000 a year, enough to meet national demand. In 1987, the total capacity reached 200,000, with 43 registered companies, by which time the pump was being exported to countries all over the world.

At the outset, UNICEF was one of the pump's largest purchasers, using it for a programme of "rejuvenating" boreholes by replacing worn-out handpumps with India Mark IIs. Then, as the India Mark II caught on, UNICEF became a relatively minor customer, purchasing around 6,000 pumps every year for the rejuvenation programme. More importantly, it paid for pre-delivery quality assurance inspections of all handpumps leaving the factory, not only for its own orders, but for all pumps purchased by state governments. These inspections continue to be performed at UNICEF expense. Between 1985 and 1987, 430,000 pumps underwent these inspections. In time, this task will be taken over by the Indian Bureau of Standards (earlier known as the Indian Standards Institute).

At the time it was designed and went into production, the India Mark II handpump represented a vital breakthrough in low-cost technology for village water supplies. There was no other deepwell handpump available on the market suitable for heavy use in areas where the static water table could be as low as 60 metres. The India Mark II not only became a mass production item, adopted as the

standard pump for village use throughout India, but it has since been widely exported and used in Africa and Latin America, as well as in other countries of Asia. It is today's best-known handpump in the rural water supply business worldwide.

Although the development of the pump depended in many important respects on UNICEF involvement, UNICEF had little to do with developing the basic principles of its design. What UNICEF did was to make possible the standardization of a design and the mass production of a pump very similar to the Sholapur pump, for use not only in a handful of villages or in one water-scarce Indian state, but through the entire length and breadth of the hard rock peninsula. Here was a major occasion within the evolution of the national Indian water supply programme when UNICEF provided a bridge between small-scale, local, humanitarian effort and the large-scale, institutionalized requirements of government service delivery.

Community involvement and maintenance

All pumps break down, at some time or another, however sturdy their construction. Thus, the administrative arrangements for maintenance, tools for repair, the mechanical competence required to use them, the cost of spare parts and their availability have to be considered as factors of pump design. When the India Mark II was on the drawing-board, its designers gave some thought to questions of maintenance and repair, although their primary consideration was to produce a pump whose sturdiness ensured that professional mechanical attention during its lifetime would be kept to a minimum. How easy or difficult, both from a technical and a managerial point of view, it would be to carry out a typical pump repair was not ignored, but was given relatively less design attention.

The cylinder, or water-lifting chamber, houses a piston that is actioned to lift water when the handpump handle, on the surface, is pushed downwards. In all deepwell handpumps, this portion is below the water table, far down inside the borehole and in the case of the India Mark II, the piston has to be removed whenever its washers wear out. In the original India Mark II, this piston could only be extracted jointly with the cylinder, by first removing the rising main - lengths of heavy galvanized iron pipe - with special lifting tools. When the pump was first developed, this did not appear to be a major disadvantage. No concern was felt that this would eliminate local users or village mistris as key maintenance and repair agents for the pump.

In fact, the last type of maintenance structure to recommend itself at that time would have been a village-level operation and maintenance (VLOM) system - the currently accepted approach,

which places the key responsibility for pump management and repair in village hands. In the early days of the programme, these tasks had been left to the gram panchayats and their employees, the mistris and the results had not been satisfactory. The pump's developers took it for granted that competent professional mechanics would be called in from state or district Public Health Engineering Departments to mend the pump when necessary, using the appropriate tools and expertise.

To build up an institutional network for maintenance in each district - suitably mobile, adequately staffed and budgeted, regularly re-provisioned with spare parts, in states where thousands of new boreholes and handpumps were being installed each year - could never be a speedy process. The fact that there is no short-cut to capacity building makes the breakdown rate of any equipment installed in rural areas one of the most critical factors in its suitability. If the institutional capacity for handpump maintenance and repair had already been in place when the India Mark II was developed, durability would have been less important. The lack of maintenance capacity is still, 10 years later, the most widespread village water supply problem in India. Sturdiness versus simplicity of repair is a continuing debate in the evolution of handpump technology.

In the late 1970s, UNICEF began to devote more attention to handpump maintenance as an independent RWS issue. Most state PHE organizations did not have adequate administrative arrangements to carry out the responsibilities of keeping handpumps in running order, including the distribution of tools and spare parts. All their efforts were still going into the installation of boreholes and handpumps. Maintenance did not figure as a priority.

The key concerns in handpump maintenance at the time were two-fold: the need for a reporting system so that handpumps that were not functioning did not languish until the authorities happened to discover them; and the need for a system in place (for which the PHE authorities could be responsible and answerable), which responded to the news of a breakdown by the timely dispatch of suitably equipped personnel to carry out the necessary repair.

Although handpump breakdowns differ considerably in their degree of severity, the effect is the same: the pump yields no water. At this stage in the Indian handpump programme, all problems and repairs required the attention of a trained mechanic, usually from block level, but occasionally from higher up the line. As far as the development of the administrative system was concerned, the need was to define a suitable referral structure and train and equip block mechanics and district PHE teams to staff it. There was as yet little idea of differentiating between types of maintenance actions and repairs to the point where the simplest could be carried out by non-technical or barely technical people at the outer rim of the administrative framework. It was not long, however, before this "basic services" model began to be adopted in RWS as in primary health care (PHC) programmes.

The three-tier maintenance system

The pioneering organization was the Tamil Nadu Water Supply and Drainage Board. In 1976, it began to operate a "three-tier" maintenance system in Tirunelveli and Thanjavur districts, consisting of a mobile repair team based at the district level, responsible for approximately 1,000 pumps; a trained mechanic at block level, responsible for 100 pumps; and a "handpump caretaker" at village level, responsible for one pump only.

Training the village-level handpump caretaker

The term "handpump caretaker", coined by UNICEF in India, has subsequently been used in many other rural drinking water supply programmes, with varying connotations ranging from barefoot mechanic to sanitary inspector. In India, the designation was in no way connected with mechanical expertise or competence to mend the pump; nor originally had it much to do with public health. The most important caretaking duties were to report pump breakdowns to the block-level authorities and to keep proper records of the pump's history: dates of repair and breakdown, actions undertaken and by whom.

The caretaker was the link between village pump users and the authorities at block level. Most villages experienced the installation of the handpump as an external, Government-controlled activity and did not perceive themselves as having any control over its workings. They had little idea of who to tell about a breakdown and no confidence that time and money spent visiting some official to lodge a report would be rewarded with success. The invention of the "caretaker" concept was designed primarily to remedy this perception.

UNICEF responded to the concept by supporting a systematic programme of training for village handpump caretakers, first in Tamil Nadu and subsequently in Andhra Pradesh, Orissa, Karnataka and other states. At the time of a handpump's installation, local officials from the Block Development Office and the Water Department selected caretakers for each pump. They looked for someone literate, who lived near the pump, was a regular user and was prepared to undertake the duties voluntarily. Young men and women were usually chosen, sometimes teachers or people with a little extra social standing.

In groups of between 50 and 100, the caretakers attended a two-day training camp, at which they were taught the pump's basic workings. They were shown how to remove the pumphead and grease the chain and how to tighten its nuts and bolts. They were also given a rudimentary course in the connections between good health and clean water and about the avoidance of sickness by enforcing hygiene in the home. At the end of the course, they were given a certificate; a log sheet with their name at the top; a supply of pre-addressed and stamped postcards with which to summon the block mechanic in the event of a breakdown; a can of grease and a set of two spanners.

The "handpump caretaker" concept represented a departure in village water supply schemes in two important respects. First, it gave an actual pump user, someone with an in-built motivation, a sense of responsibility for ensuring the pump's smooth operation. This represented the first, however fragile, step towards building a sense of community participation in rural water supplies. Second and as important, it presented the first opportunity to bring women actively into the programme.

Women as caretakers

The recruitment of increasing numbers of women, initially in Tamil Nadu and later elsewhere, marked an important evolution in the role of the handpump caretaker. Whereas male caretakers normally see themselves as village associates of the block mechanic, women naturally adopt a public health role that associates them with village-level primary health care and community development initiatives. In states such as Andhra Pradesh, where the recruitment of women as handpump caretakers is specially emphasized, the role they are expected to fulfill has virtually no mechanical content. Their training focusses on health education and on the protection of children from infectious diseases, particularly diarrhoea and others associated with water use and poor sanitation.

In 1979, at the National Deepwell Conference in Madurai, CPHEEO was encouraged to recommend that the "three-tier" maintenance system developed in Tamil Nadu be adopted countrywide. The recommendation went through and with UNICEF assistance, the training of district teams and block mechanics began. By 1980, 125 mobile maintenance teams were operating in the field.

Limitations and successes of the three-tier approach

The training of handpump caretakers, however, did not proceed efficiently everywhere. Some PHE Departments were not convinced that the third of the "tiers" - the community tier - was necessary. Even in some states which showed enthusiasm, the numbers of caretakers trained amounted to only one-tenth of the number of handpumps installed.

Part of the reason is perhaps the problem common to all programmes that use community volunteers to backstop the delivery of basic services: a high drop-out rate among the volunteers discourages officials from making the effort required to run the training courses and supervisory networks. Caretakers, like other community-based workers, can feel isolated; without institutional backing, they may become discouraged and cease to function. If the block mechanic does not appear at their command, their credibility sinks in their own and the community's estimation. In the Indian pro-

grammes, by the early 1980s, many of the caretakers in Tamil Nadu had fallen by the wayside.

In 1984, a major survey on the use and condition of handpumps in six states was commissioned by UNICEF. The overall picture was encouraging: the proportion of handpumps that were operational at any time was 80 per cent, the exact reverse of the picture of 10 years previously. However, it was not clear that this was connected with the establishment of reporting, maintenance and repair systems. Delays in reporting pump breakdowns were still common, with some remaining out of action for months. The high proportion of functioning pumps seemed to be more closely connected to the sturdiness of the India Mark II, whose breakdown rate remained minimal in the first few years of its life. The highest rate of broken pumps was in Tamil Nadu, the birthplace of the three-tier system; this appeared to be because Tamil Nadu had been in the vanguard of India Mark II handpump adoption and its pumps were among the oldest.

In contrast, in certain districts of Andhra Pradesh, a state where a strong emphasis had been continuously placed on training of maintenance personnel at all levels, the three-tier maintenance structure was able to reach the point of development where it became nearly fully systematized. Even today, the state's different tiers, at district, block and village level, keep in touch with each other and are equipped to handle their own level of activity and the maintenance system works. The handpump caretakers, both male and female, belong in a programme niche which is now a well-established part of the RWS scenery. Some groups of women caretakers have their own associations and, with guidance from their Block Development Officer, have branched out into income-generating activities. In some communities, RWS has become fully integrated in the primary health care scenario more because of the links between caretakers and other local community workers than because of an effective policy of integration of health and water supply at the official level.

However suited the three-tier maintenance system is to certain states, it is not necessarily suited to every political, geographical and environmental situation. In the late 1970s, anxious that a structured maintenance system of some kind be introduced in all states, UNICEF had perhaps somewhat hastily cited the three-tier system of Tamil Nadu as a universal pump breakdown panacea and the CPHEEO had given its official blessing. What ought to have been recommended possibly was the principle of training and equipping several maintenance tiers, each to be responsible for tasks of increasing technical complication and the initiation of a debate in every state as to how best to apportion these responsibilities and build up human and technical capacity.

Somehow, the principle of village-level reporting and referral up the line to the appropriate level of technical expertise became submerged in an unexpected controversy that developed between various protagonists about the desirable number of maintenance "tiers". How many tiers there should be and at which tier the onus of responsibility lies, has subsequently been recognized as a matter

for each state PHE Department to work out according to the logistical, bureaucratic and technical environment in which it is functioning.

1) Experimenting with "one tier"

In 1981, a different approach to handpump maintenance was developed at Tilonia in Rajasthan by a pioneering NGO, initially with assistance from UNICEF. This "one-tier" system was based on the idea of training local school-leavers as village pump mistris under the Government-sponsored TRYSEM (Training Rural Youth for Self-Employment) programme. The basic concept was that the task of handpump maintenance should be brought within the socio-economic life of the village. If local mistris were adequately trained at local technology institutes, equipped with the proper tools and given access to spare parts, the idea was that they could carry out the majority of handpump repairs without calling in the block mechanic or the district repair team.

As a result, the Rajasthan Water Board adopted the mistri maintenance system throughout the state. Although the system was attractive from many points of view, its designation as a "one-tier" approach was misleading. The mistri system did not eliminate any official tier of the Government service, though it did reduce the degree of their involvement. The mistri was both a substitute and an addition to the standard system; it turned out that he could not operate independently of the Government PHE authorities since almost the entire context of his "self-employment" - tools, equipment, spares, remuneration, accountability - was the Government RWS programme.

On the other hand, the mistri did eliminate the caretaker in the role of unpaid reporting agent and public health educator. The important change in the maintenance system was, therefore, the creation of a completely different type of cadre, one with mechanical responsibilities, at the community end of things. In order to give mistris an identity separate from the PHE service and to make their services accountable to the community, they were appointed and held answerable to the village panchayats. This meant that although the funds to support the maintenance structure and pay the mistris a small stipend were provided by the Primary Health Engineering Department (PHED), their activities were outside the authorities' exclusive control.

As in all situations where accountability is unclear or polarized, the relationship between the mistri, the panchayat and the officials responsible for water supplies has had a troubled history. The mistri was often caught between his obligations to two masters, struggling to keep his beat of handpumps repaired without back-up from either. Over-dependent on the panchayat for his job, stipend and spares, he was criticized for failure to carry out his duties effectively. The authorities were sometimes reluctant to give his expertise the benefit of the doubt or to respect the fact that many of his problems derived from systemic weaknesses outside his control.

2) Designing a more serviceable handpump: The VLOM India Mark II

It was a misfortune of timing that the village mistri and the village panchayat were brought back into the maintenance picture at a moment when the handpump was not technologically mature. The original India Mark II was not designed for village maintenance. As a result, the tools were very expensive for the mistri to purchase, the possibility of error or accident relatively high and the physical strength needed for removing the below-ground pump parts too great for him to manage his beat of 30 or so pumps on his own.

In the early 1980s, a new design criterion was established for handpump design, not only for the India Mark II but for many pumps designed for use in rural drinking water schemes: the VLOM criterion. Simplicity of maintenance and repair began to be seen as the key to designing a pump which made possible village-level operation and maintenance of rural drinking water supplies.

In 1982, efforts began to redesign the India Mark II into a handpump that could be repaired without expensive tools and lifting gear. Any design change in a standardized item of equipment in such widespread use as the India Mark II - 150,000 a year are produced for the home market alone - has to be considered carefully. But change has been forced upon the Mark II because it was not possible to advocate village-level pump maintenance unless the pump met the necessary technological criteria. The change in the new VLOM version was that the below-ground mechanism positioned the cylinder into a wider rising main, so that the piston can be extracted through the rising main rather than with it. Consequently the time and muscle power needed to maintain the subsurface components of the pump were substantially reduced.

The VLOM India Mark II is now in use in various demonstration areas, including Ranga Reddy District of Andhra Pradesh and five or six others in different parts of the country. The Federal RWS authorities are encouraging its adoption in as many states as possible. There can be no doubt that the reduced manpower, the speed and the simplicity with which a cylinder washer can be replaced and other repairs undertaken, will sell the new version of the pump as effortlessly as its sturdiness sold the old. The VLOM Mark II will usher in a new era, in which the users in the village will be able to play a maintenance role. In some areas, the handpump caretaker will assume the role of the barefoot mechanic; in others, the mistri will logically take over.

3) Privatizing maintenance

The maintenance system attempted in Rajasthan was the first visionary step towards a transfer of handpump maintenance into the private sector. This evolution ought to be encouraged and must occur at some point. If it does not happen before, it will surely come when India Mark II pumps, many of a certain age, are so thick

upon the rural ground that public sector maintenance becomes self-evidently economically impracticable. Already, over one million are installed.

With the VLOM version of the India Mark II in place, there is a need to design a workable relationship for future handpump maintenance between the public and private sectors, both for labour and spare parts. There is approximately a five-year breathing space before the rate of handpump breakdown reaches the crisis point, which can be anticipated when many of the pumps installed in the early 1980s begin to wear out. It is during these five years that the authorities need to take another visionary step. Full community involvement in handpump maintenance, using caretaker, mistri, or both, needs to be established.

Hardware: From technology transfer to capacity building

In 1968, at the height of drought in Andhra, two Halco Tiger drilling rigs were provided to a Methodist Mission in Hyderabad to help its Water Resources Unit with a crash programme of substituting boreholes for dried-up open wells. Difficulties with foreign exchange and spare parts encouraged the engineer in charge to start manufacturing replacement hammers. Production expanded into other accessories and in 1972 the Water Development Society (WDS), by now an independent registered charity, built its first three rigs. By the end of the decade it was manufacturing over 100 rigs a year.

WDS is a unique organization, established on a non-profit basis, with the primary purpose of helping expand water supply services in such a way that they reach the poorer members of society. It has never patented any of its designs and it sells some of its products at much lower prices than they actually command on the market when traded by others. All profits from the company go into water, sanitation and health-related social welfare activities. These include its own drilling programme in tribal and scheduled caste areas, where it usually provides boreholes free of charge. By 1988, it had manufactured around 1,500 drill rigs. WDS executives estimate that there are 3,000 rigs currently in private business hands in India.

WDS has played an exemplary and public-spirited role in fostering the growth of an indigenous water-well industry, but the story of its success is also a reflection of the surge in demand for water services that followed the introduction of high-speed hard rock drilling into India. The impact on rock of a machine that could punch a hole in a day was almost equalled within a relatively short time by its impact on social and economic life in the countryside.

No one could have foreseen what a tremendous success boreholes and handpumps would become: extremely popular with the people, good for vote catching at election time and excellent for

businessmen and politicians alike. This was made possible by the advent of high-speed drilling, the successful demonstration of the technology both for borehole production and for bringing water out of the ground by pumping and the capacity of India's industrial base to assimilate it quickly.

With the steady expansion of the water supply sector, state Water Boards and PHEDs became customers for down-the-hole rigs and accessories as well as handpumps. Within a few years, private contractors were setting up with rig and crew and competing for a piece of the action in what was becoming a boom industry. The beginning of the Sixth Plan period (1980-85) coincided with the launching of the International Drinking Water Supply and Sanitation Decade (IDWSSD) and the Indian Government commited itself to 100 per cent population coverage for rural water supplies by 1990. Four per cent of the total national budget was allocated to the sector over the Sixth Plan period.

As the state bodies increased their own drilling fleets and developed partnerships with the private water-well industry, the UNICEF role shrank in proportional physical terms. UNICEF did maintain its close co-operation with the progress of RWS, identifying itself with the goal of "Water for All" and sustaining its role as selective technology initiator, capacity builder for State PHEDs and pacesetter for programme evolution. This was not so much a question of carving a new role as of retooling an existing one to fit the expanded circumstances of what had become the largest rural drinking water supply programme in the world.

By the mid-1970s, UNICEF had provided around 140 drill rigs to the programme, gradually turning their ownership over to the State PHEDs. Having bowed out of drilling rig provision, 1978 presented another turning point in the form of increasing technological challenge. The particular virtue of the blast hole DTH hammer rigs was that they went through hard rock with spectacular ease. They were less effective, however, at cutting through deep layers of soil overburden above the rock, or at drilling in boulders or alluvial formations. What was needed for these conditions was a rig with more power, one that could drill a hole of a wider diameter to a greater depth under a wider range of geological conditions.

The other continuing problem was the increasingly depleted water table. More powerful rigs were also needed in drought-prone areas with low static water levels to ensure that new boreholes could be drilled deep enough not to run dry in years of poor monsoon.

The only way to add power and torque to the drilling equipment without ending up with a vast compressor and an outsized piece of machinery was to use rigs that used hydraulics for everything except the air-driven hammer. Predictably, there was some resistance to the use of these "new generation" rigs: hydraulics were said to be unsuited to a developing country environment. But the arguments in favour of their introduction were essentially the same as had brought in the "old generation" rigs a decade earlier. The complications of water-well drilling in the Indian subcontinental peninsula required the most up-to-date technology the industry

could muster. India's Government and industry engineers had already shown that they could respond to new technology with the capacity to maintain and repair it.

Between 1978 and 1984, UNICEF imported around 100 hydraulically operated rigs in a new phase of borehole technology transfer. Once again, the introduction of new equipment was accompanied by capacity building in the various states, with UNICEF itself hiring and deploying experienced drillers to assist with training and staff development. The rigs proved themselves very quickly due to their strength, reliability and cost-effectiveness.

Re-identifying "problem villages"

The introduction of "new generation" drilling rigs was only one of several new technological approaches developed to meet the challenge of "Water for All". At the beginning of the Water and Sanitation Decade, a new survey identified 230,784 villages as falling into the category of "problem villages". This increase in the tally was partly explained by a refinement of the definition, partly by a greater degree of exactitude in the surveying techniques and partly by the political impetus the programme had developed. The highest priority was attached to no-source villages, which were often the harijan and tribal hamlets located in more remote and neglected areas. As the 1980s advanced, between 35,000 and 40,000 problem villages were provided with a water supply each year. Those that remained unserved were mostly what became known as "hard core" villages, either inaccessible or in locations where water was difficult to find.

Under these technically challenging circumstances, other needs emerged in the introduction or adaptation of equipment and in training people in its use. The rate of successful boreholes was increased by introducing geophysical investigation as a routine part of site selection. An estimated 210,000 boreholes were drilled annually, with a success rate of 85 per cent. However, in some parts of Maharashtra and Madhya Pradesh, where sites were chosen according to random selection or community convenience, the rate of dry boreholes was as high as 40 per cent. In Tamil Nadu, where geophysics was exclusively used, the success rate was 97 per cent. There are places in the remote north-eastern areas, notably in Mizoram, where the introduction of geophysical surveying has made it possible to drill boreholes where previously all efforts had been unsuccessful.

Estimates based on a unit cost of US$1,200 per borehole (this is a modest estimate: hard-rock drilling averages US$1,500 per borehole) suggest that lack of systematic geophysical survey was costing the national programme US$37 million a year. Between 1985 and 1987, UNICEF imported 30 "terrameters" for use by the states in resistivity measurement. This followed the import, over a longer period, of a variety of geophysical survey instruments, including electrical well-loggers and magnetometers, little of which was being used in the field because of lack of technical manpower

and know-how. Therefore, since 1985, UNICEF has commited resources to helping the states build up their capacity for geophysical exploration. Specialized training courses sponsored by UNICEF have been held in scientific and technical establishments in different parts of the country.

Testing other approaches

Other approaches have also been developed for particularly remote and mainly tribal areas in the hilly north-east. These include the gravity feed schemes serving a total of 39,000 people in Mizoram, Manipur, Meghalaya, Sikkim and Uttar Pradesh.

In some remote areas of the north-east where no other water supply system is feasible, assistance has been given to try out techniques for rainwater harvesting. In Manipur State, a training-cum-demonstration construction of household ferro-cement rainwater collectors has been carried out and was well received by the community. The programme to introduce this new technology is now being continued by the state, with UNICEF co-operation.

Another role that UNICEF has taken on is to develop methods of drilling in areas unserved by the rigs deployed under regular state government programmes either because they are too difficult to reach with conventional equipment or because drilling conditions are too complex. One approach has been to transport rigs separately from their compressors by mounting them on twin trucks. This allows better manoeuverability where tracks are poor without putting the equipment at a disadvantage for normal terrain. Rigs have also been mounted on crawlers and on tractors for extra steep mountain gradients, but it takes a very long time to move this equipment around, inhibiting quick deployment between sites.

One of the most recent drilling innovations is the development of a specially light-weight rig, known as the Halco Tiger II. Mounted on its own carrier, this "all-terrain" rig has been designed to reach unserved pockets in hard rock states previously inaccessible to any rig. It has four-wheel drive and four-wheel steering, as well as a very low centre of gravity to ensure stability and mobility under the worst track conditions. The first four of these rigs were imported by UNICEF in 1986, the first of two years in which India endured its worst drought of the century. Under a special UNICEF drought relief aid package, another 20 all-terrain rigs were delivered in 1987 of which 10 were Tiger IIIs, an updated version of the earlier Tiger IIs.

By the beginning of the Seventh Plan period in 1985, the state governments owned 695 drilling rigs and a further 1,667 were operated by private owners (Atlas Copco, Ingersoll Rand and Halco) under contract to State PHEDs. UNICEF-provided rigs numbered 95, drilling between 6,000 and 7,000 boreholes a year, or around four per cent of the total. Two-thirds of the boreholes by this stage were being drilled by private contractors. With such a relatively small presence in the national programme, UNICEF has concentrated on trying to set quality standards in the deployment and use

of the rigs it has provided in the hope that these management methods will eventually be adopted nationwide and the entire programme become more cost-effective and productive. Norms have been set for minimum drilling depths, for casing procedures and for other aspects of borehole design and handpump installation, which ensure that the hardware package is of as high a calibre as possible.

Reforming information and monitoring systems

One of the areas to attract the Government's attention is the development of management information systems, particularly for monitoring drill rig utilization and output. The target number of boreholes to be drilled by each rig depends on drilling and terrain conditions. These targets can only be met if rigs are deployed as efficiently as possible. Time must not be wasted in moving rigs long distances from site to site because of poor planning, or in waiting for spare parts or other unnecessary delays. At the same time, drilling operations must not be skimped on if quality is to be maintained.

Since 1983, UNICEF has been developing a computerized rig monitoring system which gives a full picture of the performance of each of its own rigs, measuring both their utilization rates and qualitative and quantitative data about their output. How well performance is measuring up is fed back to the engineers in the relevant state departments through the UNICEF engineering team.

The Government has requested UNICEF to assist the states in setting up similar systems, initially for state-owned rigs. At present, many states are operating their rigs at 50 per cent of their capacity or less, while simultaneously employing contractors who juggle commitments from state to state. Under the Government's new policy, outside contractors will be used much more sparingly and only when state equipment is over-stretched, as proven by proper monitoring. In time, the system will expand to cover all rigs used in the national programme.

A monitoring system for India Mark II handpumps is likewise being set up. By using cardex systems at block and district level and feeding the information into computers at state level, it will be possible in time to call up information about one or all of the India Mark II pumps, randomly selected or in a specific block or district. Rates of installation, or breakdown, of pumps in given localities will be correlated with critical questions such as age of pump, maintenance system, community access, delays in reporting and adequacy of training.

The success of the India Mark II handpump and the close association of its development with UNICEF, has tended to eclipse the vital role UNICEF has played in developing the national capacity for reaching and tapping the elusive Indian groundwater supply. Yet without boreholes, there is no use for handpumps; and without quality hardware, there is no use for water supply programme software. Criticism is often levelled at the Indian programme and

at the UNICEF role in it, because it has fallen down on both the sanitation and the health education side. Hardware may not be everything, as conventional water and sanitation wisdom has been underlining for nearly a decade. This should not be allowed to detract from the extraordinary record of the UNICEF contribution to the programme's hardware in India and of management systems to make it work at maximum efficiency. Judged by technical and managerial programmatic standards, rather than against the very different parameters of impact on community and child health, it is one of the most impressive UNICEF achievements anywhere in the world.

The public health dimension: Strengthening the software

The disposal of human waste has been virtually non-existent in the national agenda of priorities in India. This is in total contrast to water, which has earned both political limelight and leverage. With acute population pressure and high levels of urban and rural squalor, however, India faces a sanitation crisis in the making.

Until very recently, there was nothing more than verbal recognition in the national Rural Water Supply and Sanitation (RWSS) programme that the disposal of wastes that pollute the environment and spread disease ought to be a principle target of public health engineering.

In documentation of the 1970s, there were expressions of intent to encourage the RWSS authorities to emphasize health and hygiene education as a part of the delivery of rural water supplies; in effect, they remained paper exhortations. No echelon of the health care delivery service was ever made responsibile for public education on the relationship between water, dirt and disease.

The lack of attention to the public health dimension of water supplies and sanitation is of particular concern to UNICEF, an organization that justifies its inputs to the sector on the basis of their impact on child survival and health. In India, there can be no dispute about the negative impact on children's lives of water scarcity and lack of sanitation: around 1.5 million children under five are estimated to die each year as a result of diarrhoea and half the children aged less than one year suffer at least one bout of acute gastroenteric infection. By the early 1980s, well over 50 per cent of the rural population had access to clean water while less than one per cent had access to a latrine.

In 1981, at the launch of the Water and Sanitation Decade, the Government of India declared a target of 25 per cent for rural sanitation coverage by 1990. UNICEF prepared systematically for the first time to redirect the orientation of its support to the sector by putting a great deal more effort into software, both for sanitation and health education. Up to this point, support to sanitation had largely consisted of latrine construction within urban basic services

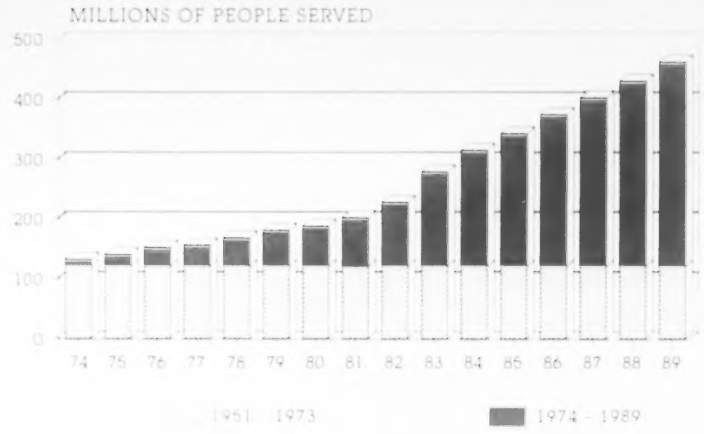


Fig. 6: Drinking Water Programme - India
Cumulative service coverage - water

and other community development programmes and an occasional suggestion that the CPHEEO do more. However, the CPHEEO priority was meeting the Decade targets for water supply installations.

Using NGOs as conduits

A number of NGOs, some of them Gandhian, some involved with slum renovation, others with community health projects, were already active in latrine construction. On an ad hoc basis to begin with, UNICEF became involved with various NGO community-based sanitation initiatives. The hope was that UNICEF could repeat the role it had played in the evolution of the water supply programme and act as a bridge between pioneering, often small and isolated, NGO initiatives and the adoption of a service delivery approach by Government. The operational activity would be carried out by institutions at state level and below, while policy guidelines and financial resources would emanate from the centre.

The first step in this evolutionary process was to broaden the definition of "sanitation" to cover all aspects of cleanliness - personal and environmental - that have an impact on health. Many unsanitary practices, such as leaving cow-dung and garbage lying around and allowing stagnant water to collect in puddles, could be tackled at considerably less expense than latrine construction. Since very little existed in the way of educational literature on the relationship between water, dirt and health, a set of flash cards on six topics was produced, embracing not only personal and domestic hygiene, but also vector control, food cleanliness, drinking water storage and the use of smokeless chulhas (stoves).

These materials were for the use of health educators, community development officers, school teachers and workers in anganwadis (pre-schools) and in other social programmes where women and children were the target. Beyond the NGOs, many of the integrated and basic services programmes supported by UNICEF provided a natural channel for dissemination. The materials were supplied to training institutes, including the Environmental Sanitation Institute in Ahmedabad, whose courses for educators, masons and other key personnel were also supported by UNICEF. Links were also made with the Boy Scouts and Girl Guides movements, the Jaycees and some of the large industrial enterprises that have housing colonies and social programmes for their employees.

One important principle to emerge was the need for community participation in any kind of sanitation enterprise. NGO activities emphasized the provision of latrines on the basis of repayment. Where latrines are provided free, without any attempt to motivate or involve their recipients, they usually remain unused. Local masons were trained in construction to keep costs down and to create a capacity in the community for meeting demand for latrines on an ongoing basis.

Enhanced support for sanitation

In 1985, at mid-point in the Water Decade, it became clear that something more would have to happen if any progress towards the 25 per cent rural sanitation goal was to be made. For the first time, the Department of Rural Development devoted significant resources to sanitation under the Seventh Five-Year Plan. UNICEF co-operation in new sanitation initiatives was requested. These included the Central Rural Sanitation Programme, and the sanitation component in two other rural development programmes aimed at improving the lives of tribals and scheduled castes - the National Rural Employment Programme and the Rural Landless Employment Generation Programme. UNICEF was invited to allocate considerable resources to support these efforts and looked forward to a major governmental push.

The emphasis of the new endeavours was on subsidized latrine construction for the poorer members of society, not on the promotion of cleanliness and hygiene as a behavioural change, with latrine construction managed and paid for by motivated community members and institutions. By overly focussing on the provision of physical facilities rather than adequate technology transfer plus education to increase community awareness of the inherent benefits, the Government may have unwittingly inhibited growth in the demand for a better quality of life.

Already in 1986, it was beginning to be recognized that the policy was short-sighted. Following a workshop on sanitation activities hosted by the Department of Rural Development and UNICEF early in that year, it was agreed that eight "intensive coverage" states should be identified, where the authorities concerned would draw up joint plans of action with UNICEF. A

number of sanitation officers with communications and social mobilization expertise were appointed to work closely with the eight states.

Focus on training

The major emphasis has subsequently been on training. Five categories of personnel are regarded as vital links in the chain of implementation: those who run sanitation programmes; masons and technical personnel responsible for actual construction and their supervisors; primary school teachers; anganwadi (childcare) workers; and village-level motivators. Training modules for each category have been developed. As the programme gradually progressed, it became clear that much depended on the motivation of field workers.

Achievements and concerns

By 1987, it was estimated that the proportion of rural people with access to some form of sanitary waste disposal had climbed from one to three per cent. UNICEF achievements in the sector in concrete terms were modest: for example, between 1985 and 1987, 1,000 latrine construction engineers were given training compared to 2,600 drilling engineers; 13,000 handpump caretakers were trained compared to 8,000 workers and volunteers in sanitation promotion.

In the same period, around 9,500 latrines were built with UNICEF assistance at schools, anganwadis and community areas and 37,000 in private households, altogether reaching 800,000

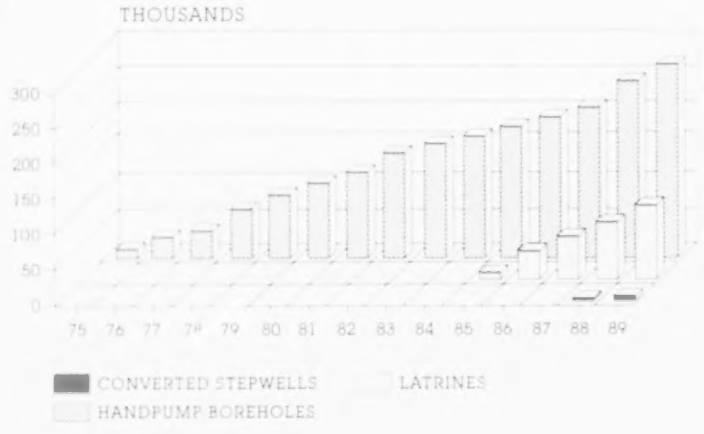


Fig. 7: Drinking Water Programme - India
Cumulative physical outputs

people. This compares with 18,000 UNICEF-assisted boreholes and 19,900 UNICEF-provided India Mark IIs, reaching at least 4.5 million people. UNICEF placed its major emphasis on Information, Education and Communications (IEC) to change attitudes and create demand.

Health education activity has been expanded to include TV and radio campaigns about water conservation, hand washing and environmental cleanliness. A knowledge, attitude and practice study was commissioned as a basis for developing an effective media and non-formal channel strategy for tackling in-built habits concerning water use and refuse disposal.

Software and health education components continue to be a source of concern for the Indian RWSS programme. There is recognition that promoting sanitation awareness is an uphill task. The water supply programme in India has soared so far ahead in size, popularity and political will, that it would be almost impossible to attach sanitation to it in the way that programmes elsewhere have managed to do. Some other strategy is needed and at the moment, only strands of it have yet appeared.

1985: A new push for "Water for All"

At the beginning of the Water and Sanitation Decade, India set itself the target of providing 100 per cent of the population, both rural and urban, with a clean drinking water source. This was no rhetoric but a real national commitment accompanied by full recognition of the budgetary and administrative implications. The two most striking features of the commitment were the degree of political importance increasingly attached to the universal provision of drinking water; and the acceptance by India that rural water supplies required an approach that was technologically different from public works approaches suited to urban environments.

India's endorsement of the low-cost, easily replicable, non-mechanized community water supply option, not just as a fall-back for drought-prone areas, but as the accepted strategy for "Water for All", gave a great boost to the worldwide institutional acceptance of such approaches. At the start of the Decade, many donors and policy-makers still looked down patronizingly at low-cost, low-level technology for rural water supplies as being suited to humanitarian operations, but unworthy of being taken seriously from an economic and infrastructural point of view. India's adoption of the borehole and handpump approach, coupled with gravity feed and rainwater harvesting in problem areas, helped to entrench low-cost approaches in the bedrock of water supply options all over the world.

By 1980, the Indian strategy geared to the concept of the problem village had been well established. In 1980, at the beginning of both the Sixth Plan and the Water Decade, 231,000 problem villages were slated to receive at least one new supply, mostly in the

form of boreholes equipped with handpumps. By an extraordinary achievement, 192,000 villages were reached under the Sixth Plan and the proportion of rural people with access to clean drinking water rose to 54 per cent by mid-Decade.

For the Seventh Plan (1985-90) it was decided once again to redefine the problem village target. The minimum distance from water was reduced from 1.6 km to 0.5 km and the amount of water to be provided per head per day was increased from 40 litres to 70 litres in areas where people had no other dependable source for watering their cattle. The 1985 estimate of problem villages thus redefined took the numbers back up again from 39,000 to 162,000, of which around 63,000 were "hard core". A new and energetic push was needed if the goal of "Water for All" was to be met by the end of the Decade.

National Technology Missions launched

At this point, the degree of political commitment to the goal was reinforced at the very highest level of the Indian Government. In 1985, the then Prime Minister launched five National Technology Missions to bring the most up-to-date scientific research out of the laboratory and into the field in the service of accelerated social improvement. Drinking water was one of the areas selected for a Technology Mission, under the leadership of the Department of Rural Development and with the collaboration of a wide range of environmental and scientific bodies, as well as state governments and NGOs. The intention was to mobilize all possible sources of technical know-how to give the programme the extra push needed to reach the Decade targets.

This move offered an opportunity to inject more resources and managerial guidance from the central heart of Government into the operational activities at state level and below. In areas such as the introduction of Management Information Systems, streamlining and cost cutting were the guiding principles. In others, such as the choice of media channels and software messages, local cultural circumstances were to guide local decision making. The Technology Mission also encouraged the enlistment of all possible partners in the NGO community in recognition that small-scale approaches have a special place and advocated a holistic attitude towards water conservation, exploitation and use.

The problem areas singled out for special attention by the Technology Mission were groundwater resources management, including the compilation by 1990 of a detailed groundwater atlas for every state; the problems associated with chemical contamination: excessive fluoride, iron, brackishness and salinity in the water supply; and the problem of dracunculiasis. Fifty-five districts were picked out for "mini missions", where special field implementation projects are underway, bringing extra assistance to bear on difficult geographical or geological configurations. Many of these mini-mission districts are in areas where the population is tribal or is otherwise economically disadvantaged and where local resources are scarce.

Since the Drinking Water Technology Mission represents the latest in Indian thinking on the key issues concerning "Water for All", what it includes and what it omits in the definition of priorities is significant. The prevention of bacterial infection, mostly in the form of diarrhoeal disease is an important consideration. The Mission makes no mention of diarrhoeal disease. This omission is perhaps because diarrhoea's means of transmission are so much broader than water supply alone that a scientific and technical focus concerning water quality without a massive investment in health education would probably be wasted. However, the tremendous concentration of managerial and technical effort being put into the current priority areas does inevitably mean that sanitation and health education will for the most part be left to wait until the great goal of "Water for All" has been achieved.

Dracunculiasis eradication: An entry point for health

One of the specific "sub-missions" concerns the eradication of dracunculiasis. In 1984, dracunculiasis was still thought to be endemic in 12,000 villages of India. Between 1985 and 1988, the tally was reduced to 5,000 villages, most of them in the adjoining states of Rajasthan and Madhya Pradesh and the hope was that the disease would be eradicated by 1990.

In Rajasthan, the disease in two of the worst affected districts is being tackled by the Indian Government and UNICEF in a project funded by SIDA (Swedish International Development Agency). Banswara and Dungapur, with a population of 1.8 million people, account for 11 per cent of all the dracunculiasis-infested villages in India and 27 per cent of the 6,100 affected villages in Rajasthan. The five-year project was originally known as the Integrated Guinea Worm Control, Rural Water Supply, Health Education and Environmental Sanitation Project (IGEP), which, as the name implies, incorporates a broad range of activities that gives it a somewhat different identity and management structure than the regular rural water supply programme.

This kind of project, with its separate structure from the regular PHED and health services, often more politically prominent yet partially dependent, has to justify itself on special grounds. Setting up separate control or eradication units to attack specific diseases is not usually regarded as an optimal strategy these days. It is much more capital-intensive and costly per head than regular service provision. It tends to inspire interdepartmental tensions and since, by definition, the project activities end when the disease it is tackling disappears and its whole edifice and staff is then dismantled, some of its accumulated expertise and all-around health promotive potential may be lost.

In the case of dracunculiasis, however, there are some special circumstances. Imbibing water containing the cyclops is the only means of contracting the disease. In this sense, it is unique among water-associated infections and technically simpler to eradicate since the permanent protection of the drinking water supply definitively prevents transmission. Potential dracunculiasis sufferers have to be told about the disease and how to avoid it; actual sufferers have to be told how to avoid passing it on. Since, in India, the particular combination of water supply and health education is not readily available institutionally either in the health services or within the PHE organizational structure, special projects or "mini-missions" integrating both make sense.

The integrated approach

Rajasthan's infant mortality rate is 300-400 per thousand live births, compared to 110 for the country as a whole. Most of these infant deaths take place in the period soon after birth and diarrhoeal infection is one important contributor. Therefore, the project set up to put an end to dracunculiasis in Dungapur and Banswara districts felt it necessary to spread the benefits of its resources across the whole complex of water, sanitation and health relationships and not restrict itself to dracunculiasis alone. To emphasize this approach in 1987, the project was renamed the Sanitation, Water and Community Health project, or SWACH, meaning "clean" in Hindi.

In this regard, the Rajasthan project provides a demonstration for something more than a strategy for dracunculiasis eradication. It is an illustration of how a campaign to attack a specific disease can be used as an entry point for a fully integrated village-level public health programme. The underlying assumption of the project design is that people's desire to rid themselves of a painful and debilitating complaint, once they understand how it is caused and what to do about it, can be parlayed into a more wide-ranging transformation of their water use and cleanliness behaviour. The project's innovative approach to health education and the mobilization not only of the community, but specifically of the women in the community, in time, may turn out to have been at least as important as its contribution to the eradication of dracunculiasis in Rajasthan and India.

1) Blocking transmission

Rajasthan's stepwells, traditionally the desert state's main water source, have been the major transmission route of dracunculiasis. They are designed in such a way that all those who take water from the well are bound to wade in it and to bend down and submerge their arms as they fill their water containers. The grander wells are built with flights of stairs specially to allow people to use

them as public baths. Should a person be suffering from dracunculiasis infection and the worm be in the process of evicting itself from the body, the person will unwittingly infect the entire source. The larvae the worm releases take up residence in their cyclops host and within a short time, most of the water collected from the well is contaminated.

Since it takes nine or ten months for the worm to begin emerging, it is not natural for people to connect the yearly emergence of worms from their bodies with the contamination of stepwell water by last year's sufferers. (For a further description of dracunculiasis, see the chapter on Nigeria).

The eradication of dracunculiasis requires that the cycle of transmission be broken and the first priority in Rajasthan is to stop people wading and bathing in the stepwells. The SWACH strategy is to close off access on foot, by blocking off flights of stairs and by chipping away the top few steps. Pulleys are erected so that the well is converted into a draw-well. The community, however, has to be consulted and involved: the community well cannot arbitrarily be closed or altered out of all recognition.

Although the villagers are often reluctant to give up their traditional water collection and bathing system, project teams have found that the prospect of ridding themselves of the scourge of dracunculiasis is persuasive. The engineer explains the proposal to the gram panchayat (village council) and once agreement is reached, estimates for the work are prepared. All the costs of the conversion, including pumping out the water and chlorinating the well, are borne by the project. Where the well is suitable, fish are introduced to lower the level of bacterial impurity. So far, 2,600 stepwells have been converted in the two project districts.

The other strategy for improving the local water supply is to speed up delivery of extra borewells and handpumps. Between the two districts, 9,000 handpump wells already existed. Under the project, 4,000 new wells and pumps are being installed by the Public Health Engineering Department, using its own equipment and extra rigs provided by UNICEF. Many are installed close to existing stepwells to provide a fully protected water source in a familiar location.

2) Other support interventions

There are other engineering aspects of the project: latrine construction in schools, health centres and anganwadis; and drainage, both from the handpump area, which can otherwise become a new health hazard and from the household. Special attention is being paid to handpump platform construction to enable waste water to be led away, if possible, into a kitchen garden and to provide hygienically for activities other than water collection at the handpump site: the watering of livestock away from the pump base so that their urine has no chance of contaminating the well; and clothes washing, for which special raised slabs are provided. The

incorporation of these components into the project hardware range is one of its distinguishing characteristics and illustrates the comprehensive way in which every physical aspect of the water, sanitation and health complex has been included.

A high proportion of the project energy is devoted to software, to the training of all the personnel involved in technical, social and health-related activities and to developing communications techniques. Awareness begins at home: every person employed in the project, whether a driller or a social communicator, is expected to be fully conversant with the project's overall aims and activities. Since the targets of so many of the project's benefits and exhortations to change are women, half the project staff are women.

In each district, the project has set up District Training Teams, with members drawn from the Education Department, Health Department, voluntary organizations and social services. These teams have been the major resource for developing the village cadres responsible for weaving into the fabric of community life a new code of behaviour regarding water and sanitation.

3) Community action

Community activity takes two forms: the Village Contact Drive, which is like a micro crash programme; and the selection and training of a "social animator" in every community to reinforce the water and cleanliness messages over the longer-term.

The purpose of the Village Contact Drive is to establish communication between rural communities and the project. Many of the villages are inhabited by tribal people who have had very little previous contact with the authorities. The Contact Drive gives them a chance to hear what the project has to offer and to give their own views and add to the project's basic data information vital for project planning and monitoring. The villages were originally selected by examining medical records to find out which were the most seriously affected by dracunculiasis. In the past three years, over 3,000 villages have been covered, effectively both entire districts, as the result of two Contact Drives.

The Village Contact Drives are conducted by teams of young people, usually two women and three men, one of whom is the gram sevak (village helper), the lowest-level government development worker. The rest of the team members are selected by a careful process of soliciting names from all possible local sources - schools, clubs, panchayats, voluntary groups. When the teams for a particular area have been chosen, they take part in a four-day training camp. At these camps, many of them are assigned leadership roles and are asked to do such things as organize a work schedule, plan the geographical sequence of the villages they are to cover, and share out tasks between team members.

The actual Drive takes place over a set period of 15 days and is like a cross between a pilgrimage, a hiking tour and a peregrination through the countryside by a band of strolling players. For the second Village Contact Drive in Banswara, 123 teams - 800 people

altogether - took to the roads at the height of the hot season. Few of the girls had ever spent the night elsewhere than at home. Each group walks to the closest village on its list, carrying bed rolls, a small daily allowance for food, puppets, songs and slogans.

On arrival, they tell the village leaders why they have come and seek his permission to explain about the project and collect information. The women team members gather all the village women together and discuss where people collect their water, how many stepwells there are locally and how many people have dracunculiasis. Having explained about how the disease is contracted, they discuss the conversion of stepwells and give out double filter cloths for filtering water, white on one side and coloured on the other so that users can easily avoid confusing the contaminated side with the clean. They also canvas the women's views about where new handpumps should be sited. They stick up posters and they write slogans on the walls of schools and houses.

In the evening they put on a show to entertain everyone, using puppet plays, songs and traditional stories. They sleep in the village, staying in a school building or in one of the houses of the community, staying an extra night if the community is large, before proceeding to their next destination.

4) Using social animators

The other cadre of village-level personnel, the social animators, corresponds more closely to the conventional idea of village volunteers who are given a brief training and a small financial incentive to promote healthy behaviour in the community on a day-to-day basis. All are women and the project aim is to leave in place 360 social animators altogether, backed up by visits from the Village Contact Teams of which they are automatic members. The help of the Women's Development Programme was sought in vetting candidates and running training camps. Out of more than 1,000 women who attended the camps and were observed during field activities, only 130 were picked.

This careful process of scrutiny and selection is an unusual feature for community-based programmes that normally accept the candidates chosen by the local people. Here, the emphasis is on motivation and performance and particularly on communications skills. The high drop-out rates typical of many such schemes mean that social animators must have stamina and perseverance for carrying on, even when the community is not very responsive. It is difficult to be always badgering people to construct latrines and soak-pits, or inspecting the way they run their kitchens and keep their water storage pots.

Approximately one-third of the social animators have so far been given their full course of training. To help them reinforce each other, they are then grouped into fours and fives, with one group acting as supervisor of the rest. They concentrate their

activities in two or three villages at a time. They observe the way people are using the new physical installations, whether people are using the stepwell and utilizing filter cloths and whether they are looking after the handpump. They are encouraged to develop ties where NGOs are working, or where there are anganwadi workers or other village-level cadres.

Social animators receive a small stipend each month from the project, but this incentive system has drawbacks. The Government does not want them to be paid year-round, lest they think of themselves as an established cadre of Government personnel with expectations of permanent remuneration. Indeed, when the project ends in 1990, there is no guarantee that anyone will pay them anything at all. Here is a familiar point of tension in the design of community-based programmes. The only truly satisfactory incentive system for community-level workers is one devised and run by the consumers themselves; but that is an impracticable proposition where there is no consumer demand for the service. Project managers hope that some of the social animators will be sufficiently inspired by their experience to keep on with community development activity after 1990, perhaps by establishing their own voluntary organizations.

The social animators also have special duties concerning dracunculiasis patients. They send out word for patients to come when a dracunculiasis extraction camp is to be held in a nearby locality. In the past, few patients presented themselves for medical assistance since there is no treatment other than surgical extraction and most were too poor to pay the fee charged by private doctors. Besides, if the worm broke during the operation, the extremely severe secondary effects from the toxins released into the bloodstream were even more difficult to endure than waiting for the worm to come out of its own accord.

The project felt that treatment was an essential part of its activities. It has on its staff an Ayurvedic (indigenous medicine) medical doctor who has specialized in the extraction of dracunculiasis for over 30 years. Since the project's inception, more than 7,000 dracunculiasis patients have been treated in hundreds of camps. Apart from relieving the patients' suffering and reducing the risk of further transmission of the disease, the camps are an important advertisement for other health activities. They also provide data about the disease's actual rather than estimated incidence and the opportunity for year-by-year monitoring of progress towards eradication.

There are villages reached by the project where dracunculiasis cases have been reduced from nearly 100 to none. The credibility the project earns by such results is undeniable.

The end of the Decade and beyond

Dracunculiasis is on its way out of India. For the 98,746 "problem villages" (25 per cent of the rural population), a clean drinking water supply is on its way in. In the next decade, the

problem to be confronted is how to bridge the gap between the enormously successful spread of protected rural drinking water supplies and their potential impact on rates of diarrhoeal disease and death and on health in general.

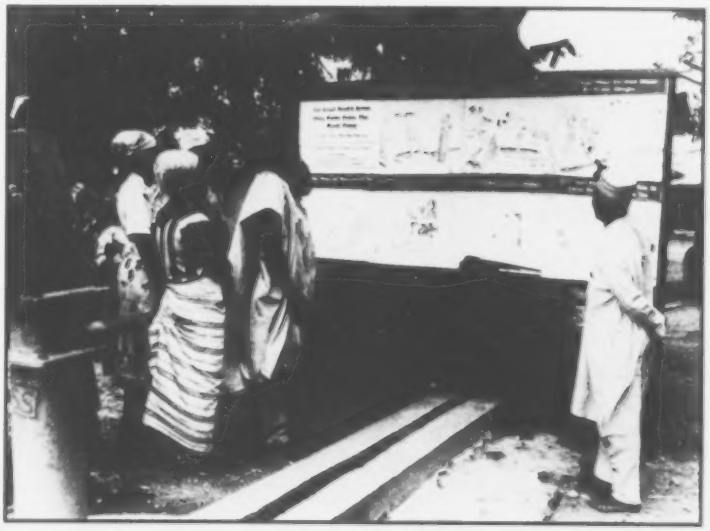
The difficulty will be how to maintain the political momentum this programme has gathered and at the same time in starting to devolve more of the responsibility for operating and maintaining handpump schemes to the communities at large. Whereas getting people to pay for the services may pose unacceptable political risks, it needs to be accepted that for these services to be sustainable, people cannot behave as though they have no stake in them and are merely their passive recipients.

People's degree of responsiveness, in the end, makes or breaks all efforts on their behalf. In water and sanitation, it would be a tragedy if responsiveness began and ended before their potential impact on health was brought concretely to bear on the less than reassuring picture of infant and child health in most Indian villages.

In meeting this next challenge, the authorities responsible for Rural Water Supplies will be looking at the depth and breadth of India's latest experiences. In the dracunculiasis programme in Rajasthan, in many small-scale voluntary organization initiatives, in UNICEF sanitation activities and in the experiments and experiences which the Technology Mission has thrown up, there will be a wide variety of health education strategy examples to follow. Transforming "Water for All" into "Health for All" is truly India's rural water and sanitation goal for the rest of the century.

CASE STUDY III

NIGERIA



NIGERIA

A programme for the 1980s and beyond

Nigeria's geographical size and cultural diversity are bywords on the African continent. Its climatic and geological contrasts are also remarkable, covering every variation of water availability above ground and below. In the north, desert herdsmen graze their livestock through the Sahelian savannah at the limits of water scarcity. Far to the south, the landscape is an aquatic extravaganza of tropical downpours, swollen rivers and steaming vegetation. Geological formations range from alluvial deltaic deposits around the mouths of the river Niger to eruptions of granite outcrop in the central and northern plains. The country's many environments add up to a hydrological complexity as rich and varied as Nigeria itself.

Of the country's estimated 110 million people, 65 per cent (72 million) live in the countryside. Many rural communities number less than 2,000 people and are widely separated from one another, particularly in the scrubland and drier parts of the country.

At the opening of the International Drinking Water Supply and Sanitation Decade (IDWSSD) in 1981, the Federal Department of Water Resources estimated that the service coverage level for rural water supply was 20 per cent and 5 per cent for sanitation, as against the national targets of 80 per cent. At that stage, no policy or strategy had been adopted that would allow Nigeria to close this gap. Low-cost technology options had not attracted serious consideration. There were few places in Nigeria where handpumps could be seen in action. Water supply systems were perceived mainly in terms of reservoirs, piped schemes and treatment plants; sanitation conjured up mains sewerage, septic tanks and flush toilets. This left most rural communities outside the scope of water supply and sanitation plans.

In the past eight years, there has been progress towards the acceptance of low-cost and appropriate technology strategies for delivering not only water supply and sanitation, but other basic services such as primary health care (PHC) and immunization as well. This change of policy has been wrought partly by forces external to the national programme. Nigeria's economic crisis in the mid-1980s, triggered by the collapse in oil prices and a build-up of external debt, necessitated re-adjustment in the form of cut-backs in consumer imports and a strong emphasis on building the nation's agricultural resource base, the basis of its economy prior to the oil boom of the 1970s.

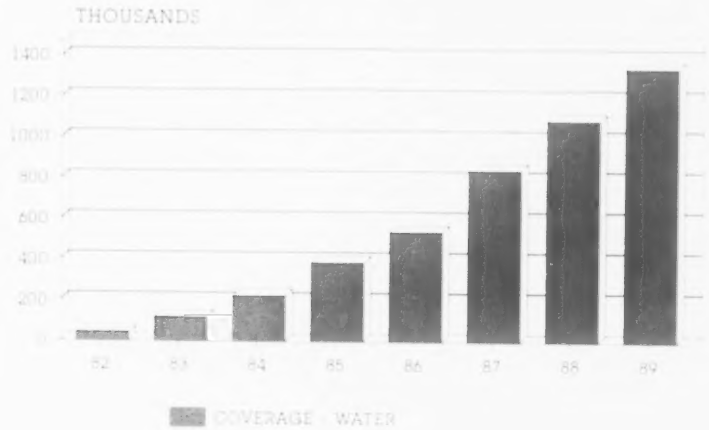


Fig. 8: WATSAN Programme - Nigeria
Cumulative service coverage - water

Change has also come from the internal dynamic of a compelling new approach to water and sanitation, "WATSAN", spearheaded by UNICEF. The technology and methodology of this approach were first demonstrated through a pilot project in Imo State, launched in 1981. Since then, five more of Nigeria's 21 states have embarked upon similar UNICEF-assisted WATSAN projects: Gongola (1984), Kwara (1984), Cross River (1987), Niger (1988) and Anambra (1988). The Federal Government has found the approach sufficiently persuasive to adopt a national plan for Rural Water and Sanitation (RUWATSAN) using a similar strategy and invested $50 million annually during the 1986-87 period. The Federal Ministry of Health has also embarked on a similar programme for rural clinics in which UNICEF is participating. Although these financial inputs are minimal in regard to the sector requirements in Nigeria, they do manifest a turnaround and a significant policy and strategy change.

What the change has been, how it has come about and the role that UNICEF has played in it is the subject of this case history.

Access to sources of water

Among countries in the region, Nigeria was a relative latecomer to rural drinking water supply services.

During the wet season, particularly in the extended months of heavy rain in the south and south-east, seasonal streams regenerate and ponds refill. In these months, when people are planting, weeding and tending the new crops, there are plentiful supplies of surface water for household use, including bathing, laundry and

watering the animals. Those families whose houses boast a tin roof can harvest a supply of rainwater during each downpour. Richer households, especially those of elders and chiefs, often have their own dug-well inside the compound. Others have to fetch their supply from a public well or an open natural source. Such sources are invariably contaminated.

Except where cultural and religious barriers restrict women's mobility, the task of water collection invariably falls to women. They, in turn, enlist their children, who go daily to the water source with the biggest container they can carry. At the best of times, water hauling is a burdensome affair, but at least in the rainy season, there is a choice of nearby sources. In the dry season, streams dry up, ponds dwindle and, as time passes, the distance to a usable source lengthens. Even in the south, many families live at a distance of more than two kilometres from their normal dry season source. In such areas, a large part of women's and children's daily lives becomes mortgaged to water collection.

Distance is not the only difficulty. Sometimes the water-hole is only a trickling spring capable of filling one vessel every half hour. Women may have to wait on line for several hours, or even all night. Many a rural housewife rises before dawn and sets off early so as to avoid the long walk back in the heat of the day with a heavy bucket on her head and a heavy infant on her back. If a woman does little else with her day once this task and the cooking are done, it is not surprising. Her energy is depleted and the amount of time left for other activities - taking her children to the clinic, tending vegetables, making pots - is correspondingly reduced.

Guarding against the contamination factor

In addition to all the problems of water scarcity, there is the problem of contamination. Water drawn from open ponds and sluggish streams where people bathe is already filled with impurities, which multiply if the container in which the water is collected and stored is not properly washed, or if the hands of the person collecting the water introduce dirt particles. In Nigeria's rural households, it is not uncommon to find faecal coliform levels of 20,000 per 100 ml of water that has been stored for drinking purposes. (The WHO safety level - set higher than many others - is less than 0.2 fc per 100 ml).

Diarrhoeal diseases, spread by the exposure of food and drinking water to bacteria, are second only to malaria as a cause of Nigerian child and infant mortality. The mortality rates are high: 140 of every 1,000 children die before the age of five. Of the 760,000 under-fives who die each year, an estimated 150,000 to 200,000 succumb because of chronic diarrhoea, often associated with low standards of personal, domestic and environmental hygiene, as well as poor nutrition. Scabies is also a common complaint. Without proper food storage, flies proliferate and spread disease. Without much water around it is hard to keep things to do with eating and drinking - hands, utensils, containers - clean, as

well as other things with which these come into contact: the rest of the body, clothes, bedding. Using water for personal and domestic cleanliness is not simple in places where every drop of water has to be painstakingly hauled.

UNICEF proposed to the Federal Government in 1980 significant co-operation in the area of rural water supply in the context of Nigeria's commitment to the goals of the IDWSSD. From the outset, the inspiration for the proposal was firmly rooted in the health consequences for women and children of the lack of protected water supplies and sanitation. The design of the subsequent programme reflected a strong preoccupation with water as an entry point for community health. The high level of diarrhoeal diseases was the principle target of attack. Another water-related disease to be targeted was dracunculiasis.

Attacking dracunculiasis

Nigeria is one of the countries worst affected by dracunculiasis in the world. Every year, an estimated 2.5 million Nigerians are affected by this disease. In some villages, the rate of infection is as high as 80 per cent. Patients are often immobilized for several weeks and are forced to stay at home, unable to work or, in the case of children, attend school. For one small region of the country comprising 1.6 million people, the economic cost of the annual toll of dracunculiasis has been estimated at US$20 million in rice production alone.

Recent experience in Nigeria and elsewhere demonstrated that dracunculiasis can be virtually eliminated from a community within one or two seasons if there is a protected source of drinking water and if people understand how to avoid contracting it and passing it on. This basic recognition made dracunculiasis a rational focus of the Nigerian WATSAN programme.

Blueprint for multi-sectorial and integrated action using low-cost technology

Until 1981, when UNICEF began to negotiate a plan of operations for water supply and sanitation assistance, there had been no comprehensive attempt to promote a low-cost technological approach to water supply delivery in rural Nigeria. Some of the decision-makers were reluctant to accept that handpump schemes, rather than higher yielding boreholes with submersible electric pumps and overhead tanks, were the right approach for relatively small and often remote communities. The reality was that scattered settlements, low usage requirements among small populations, the

cost of fuel and logistical, maintenance and repair difficulties made such schemes unsuitable, uneconomical and unsustainable in the typical rural community.

A multidisciplinary approach with two unusual features was developed. First, health and hygiene education were to be given their own framework and personnel within the programme. Second, the demand among the target rural communities for water supplies was to be used as an entry point for promoting sanitation, including human waste disposal. Not only was this the first attempt to improve rural sanitation in Nigeria, but it also represented one of the first programmes anywhere to start out with an integrated water, health education and sanitation strategy rather than one resulting from a later modification to a "water only" programme. In this respect, this UNICEF-assisted Nigerian programme benefited from its late start to capitalize on the experiences of others.

Not only did the programme initiators believe that the integrated approach to water and sanitation in Nigeria would make a decisive impact on child health and child mortality, but they wanted to measure its success in doing so. This aim had a wider purpose: if the programme design managed to offset the disadvantages faced by the old-style, water-plus approach, then it could provide a blueprint for other health-inspired water and sanitation programmes in Nigeria and elsewhere. WHO and other partners in the international environmental health community were brought in and a longitudinal health impact study was included at an early stage in the programme plans. In 1982, the pilot phase began in Imo State.

A multidisciplinary adventure: The pilot phase organization

Imo State was selected by the Federal Government for the pilot UNICEF-assisted water and sanitation project for two reasons: it had a high rural population density, and had experienced a serious cholera outbreak in its northern Local Government Authority (LGA), Ohaozara. The project was launched in late 1981 and began in Ukwa, an LGA in the southern part of the state, moving on to the more remote Ohaozara in the second half of 1982.

The Federal Ministry of Social Services was persuaded from the outset of the virtues of a multidisciplinary approach and, at the state level, the project began its life with a considerable lineup of multi-sectorial support. The Imo State Ministry of Community Development and Co-operatives, the parallel body to the Federal Ministry of Social Services, was designated as the administering authority. Six other Ministries were represented on the project's State Steering Committee: Health, Economic Development, Works and Transport, Information, Agriculture and Local Government.

The administrative entity set up to run the project, operated with a considerable degree of independent authority, while formally reporting to the Ministry of Community Development. In this regard, the Imo State WATSAN project differed from the usual UNICEF formula of selective support to regular, ongoing depart-

mental mother and child health (MCH) schemes, education and social services programmes. Instead of infusing extra resources into an existing public engineering department or similar body with a view to aligning its policies towards women's and children's health, UNICEF helped set up a separate project management structure.

The Imo State project structure was designed in such a way that it bore governmental approval but had its own agenda, staff and *modus operandi*. While this type of arrangement is quite common for a campaign or a special purpose project requiring a particular set of human and material inputs to carry out a specific task over a self-limiting period, it is not usually adopted when the task is open-ended in scope and duration and a permanent capacity has to be left in place to maintain, let alone extend, service coverage into the indefinite future. Although the Imo State project was labelled as a national "pilot" scheme, with a limited duration "pilot" phase, it was also expected to install and maintain water and sanitation services in successive LGAs in Imo over a sustained period.

Pioneering a new institutional structure

The danger of establishing a virtually independent body to run a "project", rather than investing in a regular government service, is that the special body may not survive once the capitalization phase is over. In spite of this risk, a semi-autonomous project structure was adopted. If the programme approach was to represent a genuine departure from the standard way of doing things, then it had to have freedom from the pre-set attitudes and bureaucratic constraints that can exert a stranglehold on daily operations. To develop a real multidisciplinary character, it needed, in its early days, to be implemented on the ground by people able and willing to operate with a certain independence. It was hoped that a high reputation quickly established would bring it political support and financial security.

The six Ministries on the State Steering Committee eventually seconded more than 100 staff, including public health nurses, mechanics, drilling operators, community development officers, educators, sanitarians, social statisticians, typists and drivers. Initially, many of the project staff were employed directly by UNICEF, which also assisted whenever necessary with extra staff, salaries and administrative support.

Given that one of the project's principal goals from the outset was to develop a programme model that would be replicable in other states of the Federal Union, the heavy degree of external assistance may seem questionable. In fact, it was a deliberate strategic choice, designed to let UNICEF absorb much of the shock of experimentation and inevitable early mistakes. It was believed that when a programmme prototype was being designed, its performance had to be outstanding so as to allow for weaknesses and

changes in replicating it nationwide and that extra external assistance was permissible in the pilot phase as long as withdrawal was planned and scheduled from the start.

In the first year, the Imo State government met the salaries of seconded staff and some other recurrent costs in the amount of US$429,000. UNICEF inputs in equipment, vehicles, technical and material support came to US$3 million (capital and recurrent costs) by the end of 1982. Imo State was to pay 50 per cent of the project costs by the end of 1983 but, like some other elements of the schedule, this target date turned out to be somewhat optimistic.

Preparing the groundwork through a baseline survey

Once an LGA was chosen for intervention, the first activity to take place was a baseline survey, carried out under the supervision of an experienced social statistician and a group of enumerators from the planning and monitoring team. The survey results laid the groundwork for all subsequent project activities by providing a basis for selecting target communities. The project could not be exhaustive in its coverage and even less in its level of service in view of the high demand for services and the political imperative of "spreading the benefits". Depending on the physical size and demographic make-up of an LGA, between 30 and 60 "first phase" water-points might be installed among a rural population of 200,000 to 300,000. The recommended target (not always adhered to) was to ensure that every community had a water supply within easy access, with a ratio of no more than 500 people per handpump (a population-to-pump ratio higher than normally recommended).

This coverage level meant that many households in areas of scattered settlement would still be at some distance from a pump and that an absolute maximum level of consumption of 15 litres per capita per day might be obtained, assuming the handpump to be operational 12 hours a day and allowing some time for cleaning by water users. On the other hand, the most equitable and practicable strategy, given the project's limited resources, was to establish a basic minimum service in several LGAs reasonably quickly, so as to popularize the programme and build up a base for expansion. In a context where a highly sought-after commodity - new water supplies - was to be sparingly distributed, it was important to avoid unfair site selection. The survey team's data provided an independent basis for selecting which villages would receive boreholes and handpumps according to a priority basis of need, as free as possible from external interventions or bias.

The baseline survey had other purposes. Information was also collected about living standards; patterns of diarrhoeal and other types of disease within the community, particularly among women and children; knowledge about health in relation to water and dirt; habits concerning household water collection, storage and use; and systems of excreta and household waste disposal.

Promoting behavioural change through health education

The next phase was community mobilization. The mobilization team first visited the local eze (traditional king) and the other chiefs and elders to explain the purposes of the project and to enlist their support for a meeting of the entire community and their help in setting up a project Steering Committee within each locality. The subsequent public gatherings were festive as well as instructive. Volunteers for village-based worker (VBW) were invited to enroll for training, screened to ensure their suitability and given a basic literacy test. Efforts were made to ensure that women were among the candidates.

It was during the mobilization phase that all the different project teams were introduced to the village and their various activities explained, together with what was expected from the community. The voluntary nature of the VBWs' work, the fact that there would be no regular salary at the end of the training, was carefully underlined. But the hope was also expressed that each village Steering Committee, under the guidance of the local chief, would find a way of supporting the VBWs either through community levies to give them a small cash allowance, by exonerating them from the onus of community labour or by providing them with extra free help on their own farms at harvest-time.

The need to include community motivation, education and organization, especially among women, to bring about health-protective behavioural change, was already an article of faith in water supply and sanitation strategies internationally. But so far, it had rarely been put into effect on the ground in the context of a Government-run public health engineering programme in rural areas.

It is actually very difficult to dovetail the activities of existing sectors set up to run conceptually quite different services. The "software" of water supply and sanitation programmes is education and community organization around health issues; and anything to do with health belongs to the health sector.

The separate managerial structure of the Imo State project created the opportunity of doing something really different. Since the project was self-contained, it did not have to try to co-ordinate the activities of various functionaries in different services - health, water supply, education, etc. Instead, it used the staff seconded to it to develop its own "sectors". This meant it could design its own health education strategy or "software" without having to depend on health professionals at state and local levels to sanction it and carry it out.

Without the creation of a separate project entity, the Imo State project could never have set a new trend in rural WATSAN in Nigeria by allocating so prominent a role to the non-water supply or "software" components.

Training of VBWs

Training courses were launched for the VBWs, with six volunteers recruited from each community destined for a handpump. At least two of these were women. Around 50 VBWs, usually all the trainees from one area (known in Imo as an Autonomous Community), were trained at the same time.

In the earliest days of the Imo State project, the training course went on for a total of 10 weeks: two weeks in the classroom at a local polytechnic; seven weeks at home, where each VBW was visited regularly and had his or her performance closely monitored; and then a final week in the classroom before graduation. The course included a wide variety of topics, some of them only remotely connected to water and sanitation. Subjects ranged from the virtues of breast-feeding, the symptoms of various childhood diseases and the dangers of poor diet to the need for immunization.

Male and female VBWs studied the same curriculum in the same classroom. Women seemed to focus more on information about family health and childhood sickness, on the prevention of diarrhoea, on the need to wash utensils and containers and on household improvements. The men were more interested in the workings of handpumps and latrines, and in road sweeping.

During their field work, the VBWs went with their trainers to visit local compounds. This was supposed to give them experience in performing the duties expected of them later on. Their tasks included the inspection of the household water supply and its method of storage and purification; instruction in the "two-cup" system of taking water from the storage jar to drink, using one vessel as a scoop to fill the other; promotion of latrines and proper disposal of household waste and general advice about child health and the avoidance of the detested dracunculiasis.

When the VBWs had completed their training, another formal community meeting was organized in each of the various communities to which they belonged. Their own group of VBWs was reintroduced to the community and each member was put through his or her paces in front of the Steering Committee and the rest of the village. This helped certify the right of the VBW to talk on such matters by showing what kind of information could now be offered the community for its advantage. Questions and answers between trainers, VBWs and Steering Committee members dealt with recipes for oral rehydration therapy (ORT), the habits of flies and the need to boil raw drinking water to prevent cholera and dracunculiasis. In their turn, the Steering Committee members were reminded by the trainers to ensure that the VBWs were duly compensated for their work.

The length and complexity of the training, not to mention the development of training materials and reporting sheets, posters and visual aids, represented a considerable proportion of project staff time and energy. The Imo State project was trying to graft the concept of a community health worker into a public health engineering project and there were bound to be difficulties. Questions

soon began to arise about the length and complexity of the VBW training, the communities' failure to provide the promised compensation and the lack of recognition of their role by the formal health care service. A number of lessons have been learned about the strengths and limitations of VBWs and the "software" components of the WATSAN approach have been correspondingly modified.

A health and water hybrid: Software/hardware combinations

The development of the project "software" was inspired by primary health care and basic service strategies. The central tenet of these strategies for taking services right into the lives of the people they served was the recruitment and training of local volunteers, ordinary men and women living and working in the community, to act as front-line workers reinforcing regular health, education or social services.

Up to this time, water supply programme use of community volunteers tended to deploy them as "village caretakers", mostly for handpumps. Young men and sometimes women were normally trained in handpump preventive maintenance and to report breakdowns to the authorities. Some were given a smattering of health education, although this was not their primary role. In the Imo State project, however, the concept of the VBW was much broader, embracing a number of activities related to hygiene and preventive health. The model was closer to the primary health care worker than to the handpump caretaker. The mobilization of community support and the selection and training of VBWs whose role as health educators and sanitarians would be underpinned by that support, was the crux of the software strategy.

Project teams fell into three broad categories. The technical teams were responsible for such "hardware" activities as deploying all the drilling rigs, vehicles and equipment; installing boreholes and handpumps; supervising the construction of latrines; and keeping all the new services in proper functioning order. The software teams, with higher numbers of staff but little capital overhead, undertook everything to do with mobilizing support for WATSAN services in the target communities and carrying out the health education effort designed to institutionalize its benefits. The third area of team activity was planning, monitoring and evaluation, by data collection and scientific analysis, carried out both in advance of service installation and in its wake, to measure and thereby improve its impact.

Although no amount of emphasis on software could ever detract from the overwhelming importance of the hardware activities, the number of project staff devoted to software and the level of importance attached to their activities were unusually high. The most striking feature of the programme design was the careful phasing of the team activities in the field, with the software teams calling as many of the shots as the hardware teams.

Using water as leverage for sanitation

The community also learned that it was expected to co-operate with the sanitation team. A critical part of the project strategy was to capitalize on the enthusiasm for water by making the construction of a certain number of latrines, or a latrine with a certain number of compartments, a condition for water provision. The Imo State WATSAN project represented one of the first attempts to introduce organized human waste disposal to rural areas and as much leverage as possible was needed to influence people to adopt new sanitation and hygiene practices.

The original Imo State sanitation strategy was to propose the construction of one or more communal latrines, to be constructed by the sanitation team and paid for by levies raised under the authority of the eze, or chief. Some construction materials - sand and gravel - could be collected by the community, who would also contribute unskilled labour for digging and compensation for skilled work undertaken by their own masons and carpenters.

Demonstration ventilated improved pit (VIP) latrines were usually built near the market, at schools or clinics, at path crossings or at other frequented sites selected by the village. Sometimes, the chief, or eze, had the latrine built near his compound and subsidized the construction out of his own pocket. Construction was never cheap: in 1982, one compartment cost around 185 Naira (then around US$265). It has subsequently become much more expensive (in Naira terms). Costs fluctuate according to the price of cement and according to whether masonry is used for the pit lining and superstructure. A certain amount has to be used for the concrete latrine slabs, of which several are needed: a small one for squatting, a twin to cover the alternate pit and larger ones for covering the pits at the rear. All have to be strong enough to bear a good weight.

WATSAN policy decreed that each community had to build a minimum of five VIP compartments before their water supply was installed. This exercise imparted VIP construction and design know-how to local artisans, who, it was hoped, would then be able to build others on a private commission basis.

To begin with, the Imo State sanitation team met little interest in the construction and use of latrines. Some of the structures were oversized and over-solid: many local houses were not built as sturdily. The expense of this "de luxe" version of the VIP was a major inhibition, too. The team began to experiment with simpler superstructures and unlined pits, in a bid to promote their use by individual householders.

It was often not practicable to apply the "no sanitation, no water supply" rule, particularly when the community was genuinely hard up and the season lean. It could take many months, even a visit from richer relations, to raise the sums necessary for latrine completion. In many cases, communities were still offering excuses for not having finished their latrines long past the time when the drilling rig was scheduled to appear. And the schedule of such an

expensive piece of capital equipment could not be held to ransom, especially in places where roads are few and the terrain difficult. Also, it was wasteful and time-consuming to move the rig around the countryside in response to latrine construction schedules.

Adapting drilling and borehole technology

At the heart of any water supply programme is the technology that allows clear, clean, plentiful water to flow where previously it did not flow. No one who has witnessed the moment at which water is struck and joined in the celebrations of a jubilant crowd of villagers, can doubt that water supply programmes, integrated or otherwise, are water first and foremost and that everything else is a long way down the line.

Without water, a village cannot be a village, a community cannot be a community. Severe drought, desertification, the drying up or diversion of waterways and streams, the absence of something on which human and animal thirst can be slaked, are quicker and more absolute dispersers of organized human society than even war. Therefore, the ordinary people of Ohaozara or Ukwa, of Imo State and other states in Nigeria and of any environment where water is in short supply for any prolonged period during the year, get to the heart of the matter when they ask not for a VBW to serve them, nor do they ask for a latrine, but for a tubewell with a functioning handpump on top of it.

Technological overkill

In Nigeria, the groundwater table is rarely more than 20 to 30 metres below ground. Boreholes yielding enough water for a handpump supply do not usually have to be drilled lower than 50 to 60 metres. Geological formations vary from soft alluvial deposits, common near the coast, to semi-consolidated sediments, shales and sandstones and hard basement rock in the central plateaux. In the early 1980s, however, systematic and precise data on groundwater resources in the different formations throughout the country were not readily available. To cover every eventuality, therefore, the early drilling equipment brought in for Imo State, consisting of two rigs each mounted on a heavy vehicle with a built-in compressor, and for other subsequent projects was chosen for its capacity to drill in most conditions.

Although these powerful rigs were extremely impressive, they had certain disadvantages. They were expensive (around US$450,000) and they were cumbersome and difficult to move around in the type of remote and less developed countryside specifically targeted by the project. If for geological reasons a borehole

was sited in uneven terrain, it was hard to manoeuvre the rig into position. The capacity of the equipment was usually far greater than the drilling requirements warranted. In short, it was the classic case of using a sledgehammer to crack a nut. Moreover, it was inflexible. The compressor, which was not needed for rotary drilling in soft formations, was not separately mounted. Wear and tear were considerable and the costs of servicing and repairing the machines out of proportion to their performance. The cost of each handpump-equipped borehole was US$17,000 averaged out over 1982-85 and most of this was associated with drilling.

In 1986, Nigeria responded to its severe economic crisis by launching a Structural Adjustment Programme, tightening access to foreign exchange and devaluing the local currency (Naira) by 400 per cent. In these circumstances, the pressure to reduce dependence on expensive imported capital equipment became even more intense. The understanding with Imo State and with Gongola and Kwara States where the next two projects had begun, was that UNICEF would provide two initial rigs but that the costs of any further rigs or any major refurbishing of existing rigs would be met by the states. So far, even though some of the oldest rigs are now in need of major overhaul and investment, only limited budgetary resources have been allocated by states to do this.

Developing low-cost appropriate technology

Meanwhile, UNICEF has started to introduce other drilling equipment options in an attempt to open up the possibilities for groundwater exploitation. While the aim continues to be substantial cost reduction and a better match between machinery and drilling conditions, efforts also continue to facilitate the transfer of drilling technology, including the ultimate decentralization of drilling operations from state to LGA level.

In 1986, two very simple manually operated rigs were imported from Zimbabwe at a cost of US$2,500 each. Originally designed to drill to 16 metres through consolidated overburden in hard rock areas, the "Vonder" rigs underwent a number of major alterations, with the resulting "Tripod Rig" capable of drilling to a depth of 50 metres in soft, unconsolidated formations. This low-cost drilling technique, comparatively new to Africa, holds tremendous promise for the future.

A simple tripod and winch contraption, easily transportable in a pickup, which allowed a drilling bit to be driven manually into the ground and whose separate compressor and mud pump looked like toys compared to those used by the conventional rigs, could undertake the same task in formations covering 25 per cent of Nigerian territory at 5 per cent of the capital cost. These rigs were developed in the Imo State project workshop and are now being produced and marketed by a local manufacturer. In spite of the resistance routinely encountered in Imo to "outdated and unsuitable" technology,

it would be very surprising if the rig's availability did not, in time, fuel the growth of a small-scale local water-well drilling rig industry.

Another innovation was the introduction of the Atlas Copco A-60, a much smaller, more compact "down-the-hole" percussion hammer rig (four-and-a-half inches to 60 m depth) for use primarily in hard rock areas. The rig can be mounted on an ordinary trailer and towed by a Landcruiser, allowing it to be used in remote areas inaccessible to the heavier rigs. Its capacity for drilling deep and for larger diameter drilling was limited, but so was its cost: a package including two to three light vehicles, trailer, rig, compressor and mud pump comes to US$150,000, or 40 per cent of the cost of a conventional medium-sized rig with one support vehicle. Ideally this type of rig should complement a fleet of larger rigs and be deployed to specific areas.

Between 1985 and 1989, the average cost per borehole installation dropped by nearly 250 per cent - down to US$3,700, a result of the development of this less costly, more flexible set of appropriate technology options. This meant that in time, the locus of management of water drilling operations could be shifted outwards, with some of the responsibilities handled at LGA level by a unit with a small rig, answering up the line to a supervisory unit at state level. In areas suited to the Tripod Rig, drilling operations could move even closer to the community.

1) Introducing tiered structures

The hydrogeological make-up in any area dictates the technological response to the challenge of exploiting ground and surface water. In some places, options are limited to a method completely dependent on imported technology, perhaps for an indefinite number of years to come. In others, the choice can be wider. Infrastructurally, the aim was to shift away from a monolithic operation at state level only, which moves its drilling show out into the villages, its support vehicles plying great distances backwards and forwards from city to village every time spare parts and extra tools are needed. There should come a day when there is a tiered structure with a physical presence at each administrative level and vehicles, stores, back-up and supervisory duties appropriately distributed.

2) Selection of borehole sites

Before any drill bit, percussion or rotary - mechanically, hydraulically or manually driven - begins cutting into soil, the borehole has to be sited. In all UNICEF-assisted projects, this begins with the baseline survey and the identification of communities where, on the basis of population and need, one or more handpumps are to be installed. The next activity is a geological/geophysical survey to pinpoint the actual sites.

Although village preferences and the distances women have to travel to fetch water are the first consideration in selecting sites, boreholes are no longer sunk in places where scientific inquiry has not first established the probability of striking water. Since detailed interpretation of data generated by some geophysical methods is often difficult (vertical electric soundings - VES, specifically), empirical models to facilitate interpretation were developed by UNICEF for typical Nigerian hydrogeological environments. Also, geologists were trained to use resistivity equipment in sedimentary formations and electromagnetics in basement areas to identify suitable borehole locations.

The introduction of systematic geophysical exploration to help ensure optimal outputs from highly expensive and sophisticated drilling equipment represented a major contribution not only to the Imo State and other water and sanitation projects but to the groundwater exploration capacity of Nigeria as a whole. Since geophysics became an integral part of the project activity in 1984, the success rate of boreholes sunk in UNICEF-assisted projects has been consistently higher than 90 per cent.

3) Handpumps: Installation, operation, maintenance

If a high standard of geophysical interpretation, careful drilling and well development are essential for producing a good borehole, all effort and investment will be wasted without an efficient and reliable way of bringing water continuously out of the ground. For the Imo State project, the handpump selected was the India Mark II, which had been developed for use in comparable water table areas. The Mark II was sturdy, cheap and easy to import; and since the pump was not under patent, local manufacturers would surely in time be able to produce a Nigerian version.

4) Responding to a major crisis

Unexpectedly, a major crisis was encountered with the below-ground mechanism of the India Mark II. Its rising main, the pipe up which the water column is forced towards the spout, as well as the connecting rods that link the piston to the handle are usually made of galvanized iron. In some areas of Imo State, relatively high acidity of the groundwater caused GI pipes to corrode. Within months of installation, some handpumps started to yield tainted water, rust-coloured and unpalatable.

The first attempt to solve the problem was the replacement of galvanized iron pipes by noncorrosive PVC. PVC did not turn out to be strong enough. The pipes were not sufficiently rigid and play within the casing pipe allowed them to buckle. The weight of the water column, added to the stress on the joints at the topmost rising main, often caused the pipes to split or break at the joints. A variety of PVC pipes was imported and field-tested, but none stood the strain adequately.

The solution seemed to be to use stainless steel pipes where both GI and PVC had failed. This was an extremely expensive and, therefore, a far from optimal solution. But there seemed to be no other alternative at the time, at least for boreholes where water sampling showed that acidity was in the danger zone (pH < 6.5). To try to keep weight and cost to a minimum, the project's senior mechanic produced a technical design for a special "rope-threaded" stainless steel pipe, half as thick as conventional pipes and, therefore, much lighter and easier to handle. His plan was subsequently executed by a leading Swedish manufacturer and the first pipes were introduced in 1986, just in time to restore the project's foundering credibility.

In addition to its prohibitive expense, stainless steel, unlike PVC, is not available in Nigeria. Given the post-1986 foreign exchange restrictions, UNICEF would have to remain, indefinitely, the source, or at least the conduit, of supply. In addition, the new VLOM model of the India Mark II requires a larger diameter rising main: two-and-a-half inches instead of one-and-a-quarter. The result is that the costs of stainless steel rising mains for the latest pump are now even more prohibitive than when this solution first emerged.

By 1988, all the PVC pipes used for project borehole casing were being locally produced. Additionally, perforated casing pipe for screens was being machine-slotted in project workshops. Given this growth in local production capability, UNICEF began to explore ways to produce a viable PVC rising main with a Nigerian manufacturer.

The design adjustments include a stronger coupling system; "spacers" to constrain the pipe's horizontal movement in the borehole; and a wire thread slung under the entire rising main column to shift some of its weight onto the pumpstand, thereby easing the stress on the top joints by minimizing vertical movement. Some of these design ideas have been inspired by the Afridev pump, the state of the art in simple repair handpumps, which was recently developed by the World Bank and the United Nations Development Programme (UNDP) and is currently undergoing field tests in Nigeria.

For the present, however, the India Mark II is the handpump closest to local manufacture. One company has imported the components for assembly in Nigeria, hoping not only to sell to UNICEF-assisted projects but to other borehole water supply schemes funded by the Federal Government. Another company is manufacturing India Mark II above-ground pump heads and stands and is also manufacturing a pump head which is interchangeable with the India Mark II and incorporates certain design improvements.

5) Workshops' crucial role

Project hardware included a considerable number of vehicles since all the teams did most of their work in the field. To service and repair all vehicles and equipment, including handpumps, the

Imo State project established its own workshop. Subsequent projects have followed suit. In each case, a mechanical engineer has been employed by UNICEF to set up the workshop, train staff, and establish store-keeping and inventory mechanisms. The volume and value of the capital equipment assigned each project has provided its own justification. In Imo and Kwara States, the project workshops are now run by Nigerian managers.

The workshops are in a very real way the mechanisms that underpin the project and keep its parts functioning. Their priority tasks are maintenance, including the training of local mechanics in how to run and repair equipment that is new to them and the storage, inventory and tracking of all project equipment and supplies. But they have also proved a great source of mechanical creativity, helping improve project performance and cut costs.

Special parts have been manufactured on site for some of the imported equipment rather than waste time and money ordering from abroad. With UNICEF acting as intermediary, workshop managers have suggested design changes to external manufacturers and suppliers of its equipment. There has been experimentation with equipment such as the Tripod Rig; the adaptation of vehicles for special purposes, such as handpump maintenance; and even the construction of special machines, such as one for slotting PVC casing pipe.

Each workshop contains a store of pipes, pumps, drilling and vehicle components and spare parts. Recently, a computerized inventory system has been introduced to keep track of all stock items so that project stores can draw on each other's reserves if necessary. Likewise, all equipment brought in for the projects is documented and its history tracked by up-to-date computerized register. The most recently established projects house administrative offices, workshop facilities and stores in the same compound. This helps the co-ordination of hardware with software activities and enables staff of very different professional stamp to connect with each other's areas of expertise.

The workshops have also been responsible for establishing handpump maintenance systems. A mobile maintenance team operates out of each project workshop and Public Works staff in a few LGAs that are remote from the state capital have been given training as handpump maintenance mechanics and equipped with transport and tools. Except for the crisis period in 1984, when many pumps went out of action because of corroded rising mains, the maintenance record has been consistently high: 90 per cent of handpumps are in functioning order at any given moment.

6) Village-level operation and maintenance

But handpump maintenance by teams of mechanics employed by the public services, whether at state or LGA level, did not conform to the new policy ideal of VLOM. In 1986, representatives of 30 sub-Saharan West African countries met in Abidjan and pledged themselves to the philosophy of VLOM. A proper VLOM

system expects the users of water supplies installed by the public services to take over their effective ownership, to contribute to their upkeep both financially and organizationally, instead of expecting the Government to fix the handpump or the pipeline when it breaks down. The underlying thesis is that the best, if not the only, guarantee of sustained consumer service is consumer empowerment and action.

Since Nigeria's acceptance of the "Abidjan Statement", a new system of handpump maintenance designed to put the VLOM philosophy into practice has been under discussion. There are many hurdles to be overcome in inventing and putting into place a system whereby a public utility installed by the state is somehow to be privately managed and paid for in a remote and relatively poor community. This is particularly true in Nigeria, where the institutional network for the delivery of water supplies and other public services to rural areas is still embryonic. VLOM of any service, water supply or other, however desirable, cannot be a substitute for the establishment of such a network; it can be merely an important contribution to its design and effectiveness.

One essential precondition of VLOM for rural water supplies is the use of a pump that can be dismantled with an absolute minimum of special equipment, including physical strength and technical know-how. In Nigeria, the first move towards adopting VLOM was to standardize certain pumps whose design has been governed by VLOM principles. Since the handpump most commonly used for Nigeria's WATSAN projects has been the India Mark II, the modified version of this pump, with its pumping mechanism that can be pulled out of the ground without the need for heavy lifting gear, will in future be installed in all areas where the static water table is below 15 metres. In shallower water table areas, a smaller and cheaper direct action pump that produces more water per stroke may have to be considered, being both more economical and more efficient.

The first steps towards transferring the responsibility for water supply maintenance into the community is being taken by the UNICEF-assisted water and sanitation project. The plan envisages the establishment of WATSAN Units at LGA level, responsible for the promotion of sanitation and latrine construction as well as handpump maintenance. People with some mechanical skills and knowledge, owners of the small motor-bicycle repair workshops that are a feature of every small town and larger village, for example, have been identified by community leaders for training at the project workshop. These handpump caretakers, equipped with a set of tools for dismantling the open-top India Mark II pump, will each maintain between 10 and 15 handpumps in nearby localities.

In the case of a pump breakdown, the users who depend upon it will know who to summon. There will be a standard list of charges for different types of repair and payment to the caretaker will be made by the community. The initial stock of spare parts will be provided by UNICEF from the project workshop store. The intention, however, is that communities will set up revolving funds so that as spares are used and paid for, the means are created to

replenish them. The caretaker will be entitled to make a small profit on the spares as compensation for his work.

In the event of a major breakdown outside the competence of the caretaker, he will refer to the LGA WATSAN Unit, which in turn can refer up the line to the state-level project workshop. These two referral levels are an essential part of the institutional framework that even the most smoothly functioning VLOM system requires.

At this juncture, on the verge of the system's introduction, two problem areas have been identified. The first is to obtain firm commitment from LGA Councils that they will budget adequately for the operation of the WATSAN Unit at their headquarters and start to institutionalize the handpump maintenance operation more fully at that level. The second is the problem of establishing a self-taxing system in the communities. It is important that they retain control over the funds they raise, as well as pay the mechanic who repairs the pump directly. Confidence in the system will decline if the money is collected by LGA officials and held in an LGA account, since the community will then likely see themselves as unjustly taxed for a benefit they cannot identify, a procedure contradictory to the principle of community ownership, which lies at the heart of the VLOM concept. On the other hand, some of those in authority at LGA level believe that if the handpump caretakers are not under official control, they may overcharge their customers. The challenge, in Nigeria as elsewhere, is to realize VLOM in such a way that handpump water consumers are protected, or are able to protect themselves, from exploitation by incompetent or unscrupulous individuals, in public service or in private business.

The only protection, ultimately, is consumer power: both the knowledge to recognize a job correctly done and suitably priced, and the influence to obtain redress where necessary. With increasing information and know-how at their disposal, rural communities in Nigeria will reach that level of empowerment sooner or later.

From pilot project to national strategy

In 1983, Gongola State followed Imo in requesting assistance from UNICEF for a rural WATSAN project. By this time, the demonstration effects of the low-cost and multidisciplinary approach used in Imo State were beginning to make their mark. The Rural Basic Services Project was launched in Gongola in December 1983 and, by mid-1984, UNICEF had extended assistance to a third state, Kwara. The Kwara State Water and Sanitation Project was launched in August 1984. A fourth project was initiated in Cross River State in late 1985.

In none of these states did UNICEF get so closely involved in project staffing and management in the early phase. Demonstration and experimentation were perceived by UNICEF to be the initial task of the first three years of the Imo State project. At that point,

the project model was expected to be in sufficiently good working order to stand the full assumption of its management by the Imo State authorities and its replication elsewhere. Replication, in fact, came earlier and in both Gongola and Kwara, the model was still in a relatively crude condition at its adoption. The core structure was set, but at both extremities, the upper reaches of authority and the outer reaches of interaction with communities, many design aspects were only semi-resolved. Additionally, the cultural and ecologic/hydrogeologic environments in both Gongola and Kwara States required adaptation of the model to those areas.

Project structure in other states

In all post-Imo projects, the Project Manager was a senior state employee and the staff of the project were all deployed from the various Ministries represented on the inter-ministerial State Steering Committee. In the standard project framework, staff were allocated to different categories of activity, closely reflecting the Imo State project structure: community mobilization and education; sanitation; water supply; planning, monitoring and evaluation; project workshop and stores; and administration. In addition, a communications officer both acted as project public relations official and helped produce materials for community mobilization and health education.

UNICEF maintained a liaison staff representing four areas of special concern: workshop manager, geologist, building technician (for latrine construction) and health education/community mobilization officer. Their task was to advise, help, train and support, but not to take charge, through a co-ordinator whose job was to monitor the project from the UNICEF perspective. Most of the capital equipment required for project start-up was provided by UNICEF and recurrent costs were met by the State Government.

Raising the project's profile

It took some years to establish the best parameters for the relationship between the projects and the various state governments. The ministry with which UNICEF principally co-operated at federal level was, until 1984, the Ministry of Social Development. At state level, its counterpart was the Department of Rural Development of the Ministry of Local Government. In time, it became clear that this Department did not have sufficient influence at state level to run a multi-sectorial project that required a measure of prominence in the state budget, secondment of high-calibre staff from several ministries and constant liaison with their senior officers.

In Gongola State, after a shaky start, the project was transferred into the office of the Governor, with the Secretary of Cabinet having direct authority.

In 1984, UNICEF established a new framework for its co-operation in Nigeria by initiating support to the Expanded Programme on Immunization through the Federal Ministry of Health. Later, treatment of diarrhoeal diseases by ORT was added. Since water and sanitation are accepted as essential components of PHC services and the networks of VBWs in Imo and elsewhere provided a ready-made support force for these other PHC programmes, the Federal Ministry of Health became an important ally and collaborator for the WATSAN projects, even initially assuming the co-ordinating role in Cross River State.

As the number of state projects grew, so did the number of institutional frameworks in which they operated. This did not assist the process of co-operation between them, or of co-operation with the Federal Government. In 1986, the Federal Government established a new Federal Directorate with a special mandate for rural water supply: the Directorate for Food, Roads and Rural Infrastructures (DFRRI). Directorates for Rural Development were also established in each State Governor's Office and every state was to receive five million Nairas a year for rural water supply and sanitation.

This development encouraged UNICEF to suggest that the governors' offices, now the focal point for the major federal input into RUWATSAN programmes, should also handle UNICEF-assisted WATSAN projects. This move would also allow them to benefit from financial resources allocated from DFRRI.

Learning from setbacks

In August 1986, matters were brought to a head in Imo State. What had become the national model for water and sanitation projects had experienced some setbacks. (Beginning in 1984, UNICEF began handing over the project's financial and managerial reins to state government authorities, including eventual payroll responsibility for more than 100 staff). Insufficient funds had been budgeted and poorly allocated between capital and recurrent expenditures. The idea persisted in certain quarters that the project's essence was its capital equipment. Funds were put aside for the purchase of new rigs, funds which were of little use without access to foreign exchange, while existing rigs, which needed a thorough overhaul and refurbishment, were not adequately provided for. The amount allocated to recurrent expenditure was, in fact, 15 per cent that of previous years. The project was also considerably understaffed.

The Imo State project's performance, consequently, declined rapidly: in the first six months of 1986, only 36 boreholes were sunk, compared to around 60 in the same period of the previous year and only around half the number of VBWs were trained.

Here was an illustration of what can happen when an external support organization assumes a high level of financial and managerial responsibility for a project that the executing local agency may not find itself equipped to take over in effective financial and

administrative terms at the moment of hand-over. In the case of Imo State, the solution arrived at was to move the project from the Department of Rural Development into the Cabinet Office, under the direct control of the Secretary to the Governor.

Up-scaling

During the course of 1987, all state projects came under the Cabinet Offices, including the newly agreed project in Niger State. Memoranda of understanding were drawn up between the states and UNICEF concerning the obligations of all parties - the State Government, Federal Ministry of Health and UNICEF. These memoranda contain policy guidelines, levels of budgetary commitment up until 1990, descriptions of mechanisms for inter-ministerial co-ordination at state level and guarantees about staffing levels and the reservation of equipment and vehicles for their assigned purposes. In 1988, a sixth UNICEF-assisted WATSAN project began in Anambra State, the first state to contribute a considerable proportion of the funds for recurrent as well as capital costs. All projects are now fully run by the states in terms of staffing and recurrent costs. UNICEF liaison staff share their advisory services between the projects in two or three states each. Each of the projects can be used as reference and training centres by states new to the rural WATSAN business.

The WATSAN operation in Nigeria was in a position to help develop the nation's institutional capacity to replicate the approach nationwide, even for projects which were not necessarily executed in co-operation with UNICEF. The initial breakthrough in this context occurred when DFRRI in 1986 adopted the Imo State model as the preferred national strategy for rural water and sanitation supply activities.

In 1984, a master plan for rural water supplies drawn up at federal level made no mention of handpumps or gravity feed systems, or of sanitation and VIP latrines. Only mechanized boreholes and reticulated schemes were contemplated and, with a service target of reaching 55 million people, the cost was calculated at US$25 billion, or US$55 per head. By 1986, the example of the Imo State project model and the evidence of its popularity and replication elsewhere, began to influence federal rural water policy.

By the end of 1988, 770 boreholes had been drilled in Imo, 1450 VIP latrines had been constructed and 1775 village-based health educators had been trained at a cost per head of US$35, or less than one-tenth the figure in the national master plan. With all departments of government feeling the financial squeeze, low-cost approaches no longer seemed "unsuitable" for rural Nigeria.

The policy and implementation guidelines issued by DFRRI in late 1987 reflect that changed perception. It was also broadly in line with the approach advocated throughout by UNICEF, with one important exception: instead of proceeding LGA by LGA, supply-

ing an appropriate number of handpumps per population group, the policy stipulates an even distribution of 250 boreholes per state, spread simultaneously between all the LGAs. This makes it more difficult to carry out health education and sanitation activities in the carefully phased and integrated fashion needed for significant impact on health.

The commitment of the main federal authority in charge of rural development to a low-cost, appropriate technology approach, however, represented a tremendous breakthrough. Indeed, its 1989 dracunculiasis directives giving water point priority to affected villages were another step in the right direction. If the components relating to water supply and latrine construction alone were implemented - thorough geophysical exploration; appropriate drilling and borehole technology; correct installation of locally manufactured, standardized VLOM handpumps; training of handpump maintenance mechanics; training of artisans for VIP latrine construction - this would represent another major achievement.

Joining forces between all parties - DFRRI, the Federal Ministry of Health, State Governments, WATSAN projects, UNICEF, the World Bank and other external donors - was the next step in the process of "going to scale" with water supply and sanitation service delivery in rural Nigeria.

Evaluating the impact on health

In 1983, data collection began in Imo State for the evaluation of the project's impact on health. The objective was to test and prove that protected water supplies could and did mean better health if their installation was accompanied by environmental sanitation and health education, particularly directed at women.

The US$900,000 Imo State evaluation study turned out to be an impressive scientific exercise in trying to measure the health impact of water and sanitation schemes. It also made an important contribution to the project itself, helping to develop systems for monitoring and evaluating project progress on a regular basis. But there were some limitations. Mainly because the impact of the project on health was predicated on behavioural change and behavioural change cannot be guaranteed to take place according to a given schedule, it turned out to be very difficult to produce sufficiently conclusive "before and after" measurements. The study's very considerable expense was also a matter of concern and suggested a need for more modest evaluative ventures.

The data were collected from five villages in Ohaozara LGA, three in an area where the project teams started their activities in 1984 and two in control villages where activities were not scheduled until 1986. The indicators examined fell into two categories: direct impact indicators, such as the prevalence of certain water- and dirt-related diseases, of which dracunculiasis and diarrhoeal

diseases were the most important; and intervening indicators with an indirect effect on health, such as water quality at the source and in the home, use of water and sanitation facilities and knowledge about good health and hygiene practices. Baseline data were collected in the five villages over a 12-month period and surveys were repeated over the following two-to-three years as the various project teams completed their phase of activity.

Key findings

The study's key findings on the impact of the project on disease rates were that dracunculiasis infestation was significantly reduced among people living within 500 metres of an improved water source (handpump-equipped borehole) and that there was a reduction in the proportion of underweight children below age three from 6.7 to 2.8 per cent in participating villages. In control villages, malnutrition rates increased from 4.3 to 5.5 per cent over the same period. The study concludes that reducing the distance to the water supply is more important than improving its quality for making an impact on child health. This is mainly because the quantity of water used in the home for non-survival purposes, such as washing, does not dramatically rise unless the source is very close by.

There were other significant findings concerning water quality and usage and in changes in people's behaviour, or lack of them, over the three-and-a-half-year study period. One was that even where the water at the source was completely free of bacteria (fc, or faecal coliform), it often became contaminated during the trek home and was subject to further contamination while in storage in the household.

As a result, health education on clean water collection and storage has become more heavily emphasized and the water testing laboratories at each project make regular counts of faecal coliform levels in household drinking supplies as a gauge of health education impact. They have reported an average decline of 20,000 to 5,000 fc/100 ml of water; a good progress, but 5,000 is still well above the safety level. There was a large increase - zero to 46 per cent - in the number of people who used latrines; but children were not using them and faeces were still not being disposed of in a sanitary way. This finding confirmed what observation had already revealed: the VBWs were not making the impression on their clientele that had been expected. Another interesting finding was that community interaction with project personnel proved more significant to inducing behavioural changes than did the VBWs. This stresses the importance of qualified interpersonal communication.

The health impact evaluation of the rural drinking water and sanitation project in Imo State lasted three-and-a-half years altogether. The final conclusions of the study, formally delivered and also produced in a number of published scientific papers, have established the project firmly in the international literature of public health.

Internalizing monitoring and evaluation

The real impact of the study is to be seen less in its own results than in the importance attached to project monitoring and evaluation as a management tool, which came about as an indirect result of the study. Each UNICEF-assisted WATSAN project has a team whose specific duties are exclusively concerned with surveying, counting, analyzing data, measuring and testing. Each of these units incorporates a water-testing laboratory; this is a standard activity of any Public Health Engineering programme that must routinely test the chemical and bacteriological content of the water in the taps and boreholes it installs. What is by no means standard is to have a systematic programme for running regular tests on the quality of water in household storage jars; or to carry out systematic surveys within intervention communities on ideas and attitudes towards water- and sanitation-related health issues as an integral part of the project's own activity.

Although the different projects' planning and evaluation teams have not yet streamlined and synchronized all their activities, they should, in time, reach the point where they are able to chart the UNICEF-assisted WATSAN course through all the programme's inputs, outputs and outcomes, hardware and software alike. This would be a remarkable achievement. Without the original emphasis in Imo on health impact evaluation, it is not likely that this capacity would be nearly so well advanced.

Redesigning the software strategy

By 1985, exclusive dependence on VBWs in the community, to carry out the health education function and tie together the potential and actual child health benefits of water and sanitation, was beginning to seem misplaced. In the new plan of WATSAN operations, drawn up between UNICEF and the Federal Government for the 1985-90 country programme of co-operation, the number of VBWs to be trained per handpump community was lowered to four. Within another two years, it was lowered to two. Although the cost of VBW training was not high, it was energy- and labour-intensive and there were too many doubts about its effectiveness.

Many VBWs were dropping out, failing to do their rounds of compounds, once their training was a few months behind them. Others never really worked their way into the role. Some lacked the communication skills to pass on information to the community effectively. Many received neither encouragement nor remuneration from the Village Steering Committee that was meant to backstop and reinforce their efforts. Some VBWs had not been able to take in the range of subject matter they had learned and had not been taught how to overcome people's resistance by concentrating on what they would find most useful.

Since they were not even peripherally recognized by the health service system, VBWs were neither taught first aid nor were they allowed to dispense even simple drugs from a kit. This placed them

at a disadvantage. In their community health aide role, they could not hand out pills and potions; as sanitarians, they could not mend the handpump.

One service they were trained to offer was the preparation of a homemade solution of oral rehydration salts (ORS) solution to treat childhood diarrhoea. They were taught to use a clean beer bottle, boiled water and standard measures of sugar and salt. The health establishment was not opposed since ORS is not formally a medicine. There is no doubt that being able to carry out a form of treatment that mothers could appreciate and learn, conferred on VBWs a recognition less easily earned by lecturing people about their personal hygiene habits.

The VBWs' training curriculum was cut back and concentrated more closely on topics specifically concerned with water use, personal hygiene, drainage and waste disposal, with the addition of courses in the expanded programme on immunization (EPI) and diarrhoea management. The messages are more focussed, the curriculum simpler and more practical.

The problem of high drop-out rates among VBWs or their equivalent in other PHC and basic services schemes was by no means exclusive to the WATSAN projects in rural Nigeria: it is familiar from programmes and projects all over the world. The cause most commonly assigned in Nigeria, both by the VBWs themselves and by project staff and managers, was that they became discouraged when remuneration they were promised during their training was not forthcoming. No matter how carefully the training teams screening VBW candidates stressed that the work was voluntary and very unlikely to be compensated in any formal way, candidates somehow persisted in hoping that their training would provide a magic passport to a "job".

In spite of these adverse circumstances, the fact is that some highly motivated VBWs did stay active months and years after their training, managing to pass on to their communities and families enough of what they had learned about the causes and treatment of diarrhoea, about the ill-effects of dirty fingers in food. More often, their sense of motivation came not because they had been paid, but because they had derived a sense of recognition and support from some other direction.

Creating a supportive framework

Originally, it was hoped that the Steering Committees, established by the Community Mobilization teams in each village would provide a framework of support for the VBWs' work that would continue in place long after the community mobilization and training teams had left the scene. Where the chairman of the committee was a traditional leader of some standing and commited to the project goals, the VBWs might be able to count on him for help from time to time. But in most cases the Steering Committees did not remain active and the VBWs found themselves with no authoritative body or person to turn to.

Ultimately, this question of a supporting framework for the VBWs, without which they have no motivation let alone authority to call a meeting or educate people in basic hygiene, is more important than compensation. A functioning organizational framework for their activities, to guide and guard them and keep them going, is a much better guarantee that they will do something than simply delivering a monthly stipend into their pocket. One solution actively advocated during training was the formation of a VBW association. Admittedly, some of these ended up as complaints' associations about the lack of stipends, but this does not have to be the outcome.

Building the health education network

The problems of VBW motivation and retention encouraged the various projects to come up with strategies for health education that included VBW training, but that no longer depend so heavily upon them. In the Muslim states, this is particularly necessary since women, the key target group for health education, cannot be reached directly through male VBWs. In traditional rural environments, there is a limit to what can be expected from men when it comes to passing on information to their womenfolk about domestic management.

In Niger State, a number of mothers' clubs were started with assistance from the Netherlands. With help from health clinic staff and encouragement from the State Governor's wife, better-educated members from the towns are visiting local villages to encourage their rural sisters in joint activities. Mothers' clubs in Niger State are busy sewing, gardening, pot making, trading and looking for ways to make money. They also organize literacy classes and counsel less well-informed members about child rearing and hygienic living.

In Kwara State, a schools' drive has created a special youth movement in support of project goals. Here, the use of media and marketing techniques - prizes, Tee shirts, competitions and regular TV, radio and newspaper publicity - has turned the project messages virtually into household slogans. A combination of high public visibility and community organization has become the leading edge of the health education strategy.

Another new element was the use of billboards, set up either at schools and clinics or at the handpump site itself. A range of weatherproof posters setting out the seven basic messages connected to water collection and use could be interchanged with others on sanitation and dracunculiasis. One virtue of the billboards was that they provided the local VBWs with a ready-made visual encapsulation of what they were trying to put across. They also served a psychological purpose in reminding the community that their handpump was part of a wider network being installed by project teams all over the state.

Sanitation promotive measures

There have been important changes too in the way the sanitation teams operate. Instead of building community latrines themselves, the teams concentrated more of their energies on helping train LGA teams to do so, setting up slab construction units at state and LGA levels, training village artisans in construction and generally doing whatever was necessary to develop the institutional capacity to promote low-cost sanitation based on the VIP latrine.

Experience has shown that sanitation only starts to pick up momentum after a prolonged period of advocacy. In Imo, 446 latrine compartments were constructed in 1987, compared to 268 in 1986 and 192 in 1985. One community in Afikpo LGA has recently completed a 22-compartment communal VIP latrine.

In Niger State, because sanitation was dragging, the Governor's Office promoted community latrines by commanding LGAs to construct them at all LGA administrative blocks, in markets and at vehicle parks and allocated a budget to each LGA for this purpose. The project sanitation team was responsible for carrying out all the training needed in each LGA to carry out this task.

In many northern states, up to 50 per cent of households were already familiar with latrines, even though the type used is very basic and unhygienic. In Gongola, the sanitation strategy concentrates more on upgrading existing household latrines. A specially adapted single VIP latrine slab, with a hole for a vent-pipe and another for squatting, is being promoted for this purpose.

Meanwhile, the original strategy of capitalizing on the enthusiasm for boreholes to promote sanitation is still very much at the heart of the project design. The target is one latrine (compartment) per 10 compounds in the communities receiving water supplies. Though this is rarely met, it is closer to reality than it used to be, in spite of continually rising costs of all materials.

Since the price of cement continues to skyrocket and that of PVC vent-pipes is also high, the possibilities of substituting brick and woven "zanamats" - a traditional housing material - for pit linings and superstructures are being explored. There is an experiment underway in Kwara State to see whether latrine slabs could be made more cheaply of concrete reinforced with ant-proof palm wood instead of with steel rods. At several project workshops, a full range of latrine models is on display, showing different designs, single and multiple compartments and the costs of the various basic and "de luxe" models.

In 1981, there was no formal promotion of hygienic human waste disposal anywhere in rural Nigeria, nor was there a single standard VIP community latrine in any public place. In seven years, close to 3,400 latrine compartments have been constructed and put into use. The result is modest in relation to the rural population and it is far behind the optimistic targets. But it does represent the establishment of a latrine technology and a sanitation infrastructure in rural Nigeria and that is no mean achievement.

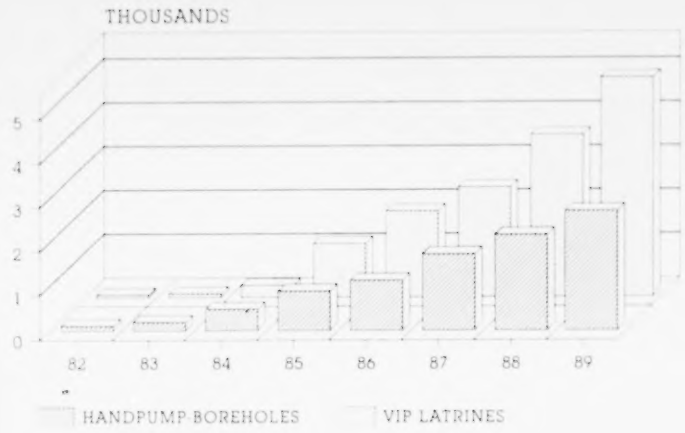


Fig. 9: WATSAN Programme - Nigeria
Cumulative physical outputs

Prospects for scaling up

Between 1982 and 1988, the combined output of the five UNICEF-assisted state-run rural water and sanitation projects was a total of 2,091 boreholes serving over one million people and enough sanitation facilities for close to 300,000 people. The schemes were highly sought after and their impact on certain diseases clearly demonstrated. Around 170,000 people had been freed from dracunculiasis in Imo and Kwara States alone and a study in one LGA in Kwara had shown that the prevalence of dracunculiasis had been reduced from 60 per cent to 11 per cent over a period of three years.

All these results, assessed against realistic project targets, were promising. On the national scale, however, they did no more than scratch the surface of the rural WATSAN problem.

In financial terms, the UNICEF contribution (1981-88) represents about 56 per cent of total WATSAN investment, which itself amounts to only a fraction of what is needed to reach Nigeria's IDWSSD targets. The UNICEF-assisted approach, confined as it is, in practical terms, to the six states where special projects have been set up, has to mean much more than its physical accomplishments if it is to make serious claims about national "scale".

The critical breakthrough has been the demonstrable success of an approach for water and sanitation in rural areas based on a range of low-cost appropriate technology options and the effectiveness of a phased, multidisciplinary approach combining water with sanitation and both with the promotion of health.

WATSAN, in the mid-1980s, has been at the cutting edge of primary health care, specially for the Nigerian EPI and diarrhoeal disease control programmes. And the adoption of the Imo State

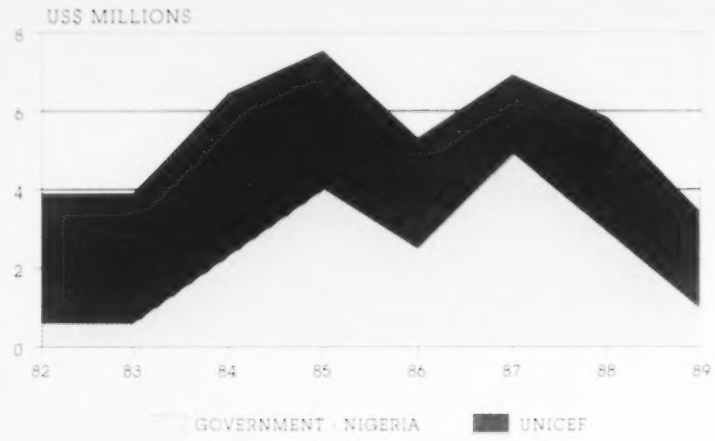


Fig. 10: WATSAN Programme - Nigeria
Annual Government and UNICEF funding

model as the national Nigerian Rural WATSAN approach holds out great promise if it can be transformed into reality on the ground.

Some developments external to rural WATSAN augur well for its expansion. These include the emphasis given to the growth of roads and infrastructures in the rural areas, plus the fact that there is no other option than low-cost approaches and import substitution. The adoption of a plan for the eradication of dracunculiasis from Nigeria has presented the WATSAN sector with a tremendous challenge and has already channelled an increase of resources.

Some developments augur less well, particularly the far from optimal initial performance of the DFRRI programme and the shortage of foreign exchange for replacing drilling equipment and vehicles in the state-run projects.

By the end of the International Drinking Water Supply and Sanitation Decade in 1990, it was intended that 90 per cent of the funding for the UNICEF-assisted state projects would be taken over by the Government, distributed between federal and state sources. The present likelihood is that 70 per cent of all capital and recurrent costs of the existing schemes will have been absorbed, mainly by the State Governments, with UNICEF continuing to meet around 30 per cent.

One of the most important issues arising out of the nationwide programme concerns the suitability, for the longer term, of setting up WATSAN projects - projects which are meant to carry out permanent functions - as separate entities, almost as separate governmental departments. If they had not been set up in this multidisciplinary manner, they would not have been able to develop and evolve the strategy for rural WATSAN the Federal Government has now adopted.

LESSONS LEARNED

LESSONS LEARNED

Key factors in scaling up

The three programmes (Bangladesh, India and Nigeria), whose case histories are described in this volume are at different stages of evolution. The Bangladesh and Indian Rural Water and Sanitation (RWS) programmes have been in existence much longer and have achieved a comparable coverage on the ground. The Nigerian programme is younger and its framework is quite different.

In India and Bangladesh, the programme is national in character, whereas in Nigeria, a series of UNICEF-assisted Rural Water and Sanitation projects have been set up in a limited number of states, to induce a change in policy and establish a replicable model for a national WATSAN strategy. In India and Bangladesh, therefore, the analysis is based on countrywide activities guided by a central governmental public health engineering (PHE) authority; in Nigeria, the UNICEF-assisted projects and approach have yet to achieve the level of a countrywide programme co-ordinated by a central (federal) PHE authority.

Adequate political will and financial resources are often placed at the top of the priority list of ingredients for expanding or "scaling-up" basic social services. This study does not quarrel with that view. Since water supplies enjoy a reasonable allocation of resources in the three countries concerned, the study does not place special emphasis on preconditions. The concern throughout the study has been to identify those policies and programme strategies that tend to promote faster or smoother expansion, and that do so while keeping in focus the UNICEF rationale for support to RWS - better health for women and children.

The evidence about the impact of political will and plentiful resources on programme quality and strategic evolution is, anyway, ambiguous. In Bangladesh, reduced political interest and resources in certain years have often proved beneficial to programme design. Community self-help has been obliged to find a substitute for Government funding and has done so effectively despite the misgivings of the technicians and managers. This has helped to promote community ownership of services and reduce Government investment, thus assisting the evolution of a programme strategy that makes reaching the universal coverage target more feasible. In India, by contrast, the tremendous political support and resources enjoyed by the RWS (but not sanitation) programme tend to dis-

courage community self-help. This, in turn, inhibits the programme from achieving much health impact - except as a by-product of other social services - since the health benefits of RWSS are not systematically promoted to the users. In Nigeria, the fall of oil prices on the world market and the budgetary constraints that resulted, facilitated the acceptance of low-cost technologies to expand services in rural areas.

An emerging model

In spite of the difficulties of cross-comparison between programmes so different in scale, context and stage of development, a model of the evolution of RWSS programmes for very large countries emerges in which there appears to be five key stages:

1. The *identification of the appropriate technology* for water and sanitation systems, balancing geological considerations with cost, demographic and socio-economic factors; the establishment of terms of co-operation between national and international institutions and with international commercial suppliers; efforts to obtain full acceptance of the technological approach from the political, technical and administrative establishment.
2. The *building of capacity* (human, logistical, technical and infrastructural), to carry out the programme; the training of technical personnel in the operation of equipment; the development of the programme framework at central and sub-central levels; the setting up of warehouses, workshops and inventory, supply and administrative procedures; the gradual shift of the locus of operations outwards from the centre in synchronization with capacity growth.
3. The *transfer of technology* to local manufacture and supply, to reduce dependence on imported equipment and develop a water and sanitation industry; the articulation of specifications and standards for locally manufactured items; the standardization of parts; the employment of private contractors in addition to public service equipment; the upgrading of technical skills for ground water exploration; the computerization of records management and evaluation procedures; the transfer of some operational and maintenance responsibilities to user communities.
4. The *development of mechanisms for community participation* and self-help, involving women in particular as the prime haulers and users of domestic water supplies; the development of linkages between sanitation, health education and water supply, capitalizing on the popularity of water supply to create demand for sanitation and advance the prospects of health impact; a further shift of maintenance of installations and supply of spare parts into the private sector by training local handymen, maintaining back-up for situations beyond their capacity.

5. The *growth of a consumer-driven service*, in which the majority of water supply repairs, some proportion of water supply installation (depending on technical feasibility) and almost all sanitation installation, is undertaken independently of the service authorities; the fueling of demand by marketing and health education campaigns and the growth of public appreciation of service benefits; a change in the authorities' role to mainly supportive and backstopping instead of operational functions.

Constraints and solutions

Tensions and obstacles typically arise at different stages in every programme.

At stage 1: Adoption of appropriate technology

Many of the obstacles that used to confront the identification of appropriate technology have been eased during the IDWSSD because of the proliferation of material about the performance of various water and sanitation technologies in different environments. A thorough review of existing approaches ought to throw up a range of technological options suitable for try-out and in-country adaptation.

Given the special character of RWSS programmes, which is the ideal Government agency for co-ordination at the central level? It is a significant feature of RWSS programmes that their formal institutional context frequently changes. In some countries, water supply is of such political significance that it commands its own Ministry; it is more often an adjunct of the Health, Agriculture or Local Government sector and over time may move around from Ministry to Ministry, depending on the national vision of the moment.

Experience indicates that splitting the responsibilities between sectors (e.g., installation and maintenance under a PHE department in Local Government or Agriculture, health education under Health), while it may sound pleasantly multi-sectorial, can leave the programme with little PH and too much E. The health sector has sometimes proven less than adequate at carrying out health education programmes on water use and waste disposal at its own volition.

Since the essential character of a rural water supply and sanitation programme is that it is designed to match its socio-economic environment, the most useful sectorial location is probably Rural Development. If this does not exist as a Ministry or is a departmental backwater, another locus with more political and budgetary influence has to be found. In Nigeria, the UNICEF-assisted WATSAN projects have ended up in the State Governor's Office. The fact remains, however, that whatever the institutional set-up to

be used - or established - it must be capable of dealing with the peculiarities of the provision of basic multidisciplinary services to the least privileged populations.

Disdain for what appear to be "simple" and "second rate" technologies is still being encountered as an obstacle to low-cost approaches, though much less so than before the IDWSSD. Even where a Government formally accepts an approach based on low-cost technology, the approach has to be sold to all levels of the administrative hierarchy; not only to the politicians, but to the technical bureaucracy, to the scientific and engineering academic establishment, to industry and to the users. Programme performance can be seriously affected if managers and technicians are lukewarm about the approach or do not empathize with it, or see it as professional downgrading. It must be fully incorporated into PHE thinking, recognized in academic curricula and covered in the technical literature and it must develop its own status.

"Appropriate" does not always mean technologically primitive. Groundwater exploration techniques, for example, need to be at the technological frontier. Both hard rock and soft formation drilling present difficulties in borehole construction for which constant technological improvement should be sought, both for quality and cost reasons. Handpump technology above and below ground and pipes for water conduction, could similarly benefit from technical improvement, as can all equipment components.

Technology selected for permanent installation needs to be both durable and easy to repair. In the past few years, there has been considerable enthusiasm for the VLOM handpump approach, which has elevated ease of repair as a design criterion to a point where it is on a par with - or even more significant than - the durability factor. The evidence from these case histories suggest that in the absence of really effective maintenance systems (which may not come before a certain level of general infrastructural development), durability is more important. VLOM pumps may demand little mechanical expertise for most repairs; but they still require a supply of spare parts and a back-up system of repair referral.

At stage 2: Capacity building

The character of much low-cost technology (boreholes and handpumps, latrines) produces community systems based on individual units rather than linked connections. Technologically, the system may be simpler, but it poses more complex managerial problems because unlike conventional water and sewerage works, it has to be managed on a decentralized basis. The degree of user responsibility required to keep the systems repaired and operational is, by definition, far higher. At the same time, it is also important not to thrust too high a degree of responsibility for the performance of installations on the users before they are technically and organizationally equipped.

Where a new technology or a range of new technologies is introduced at the outset of a programme, the natural area of concentration is on the training of operational technicians; management training, including familiarization with the programme's overall health goals, is equally if not more important. All technicians should receive some multidisciplinary training to prevent excessive compartmentalization of functions and lack of affinity between health and engineering personnel.

However durable the service installations, a structure for service maintenance has to be established from the outset. Most rural water and sanitation programmes have much more difficulty putting their maintenance systems in place than in installing services. Maintenance, since it is required continuously and more frequently as the installations age, requires a sophisticated programme infrastructure. For programmes being initiated in less developed rural areas, this is the most difficult challenge of all.

It is important to decentralize the operational locus as soon as possible, with the eventual target of placing it at a level within reach of user communities so that it can interact with them on a regular basis. However, if this process takes place too fast, control over programme quality may break down. An agreed distribution of responsibilities, clear lines of command and well-developed systems of procedures, together with enough personnel and logistical support, have all to be in place.

An important reason for exercising caution during the decentralization process is the special need for monitoring, or - more crudely - policing. Since water supply programmes involve quantities of supplies, equipment and large numbers of constructions, there is considerable room for tinkering with distribution systems, obtaining kickbacks from contractors, and other deviations from procedures. This is difficult to eliminate altogether, particularly in the grey area of public service/private sector hand-overs; but it has to be constrained so that materials do not go astray, with negative effects on service delivery and credibility.

As the process of decentralization moves ahead, inter-sectorial mechanisms need to be set up at every level in the administrative chain of command: region, district, block and village cluster. At the lowest rung on the administrative ladder, these will include NGO representatives, health personnel, local councillors and education authorities. These committees can provide a mechanism for ensuring social equity at community level, as well as forging the links at operational level between the various categories of workers whose activities contribute to overall programme success. Where a cadre of community-based helpers is to be trained, this group will provide a resource for the training programme.

Women's special interests in water supply and waste disposal should be represented at all levels of programme management. This is most easily achieved by including women in the membership of all multi-sectorial communities and ensuring that women are selected for duties at community level, either alongside men or independently.

At stage 3: Transfer of technology

Unless some process of certification and inspection is introduced, local manufacture of programme hardware may lead to the appearance on the market of low-quality products. Cheaper pumps, pipes and spare parts made by "pirate manufacturers" will beat out better-quality competitors and all the careful investment in R&D will have been wasted, seriously compromising the entire programme. Quality control over all items used in the programme also promotes standardization of parts, which facilitates maintenance and repair by allowing universal interchangeability of parts.

When a particular item of equipment is adopted as standard for a programme, design changes should not be introduced whimsically, in such a way that spare parts already in circulation are made redundant. It is best to standardize on a given range of water and sanitation equipment and adhere to their design criteria over a reasonable time-frame. The introduction of an improved version of a standardized item has to be planned and co-ordinated with training programmes for maintenance personnel and the availability of the relevant parts.

The development of a local water well industry does not preclude the importation of state-of-the-art equipment. Geophysical survey and drilling techniques for all types of formations and terrains are improving under the pressure of expanding RWSS programme activity worldwide. However, programme improvement and cost cutting must be the clear motivation rather than veneration for sophisticated hardware.

Where such equipment is necessary and has to be imported and there is no prospect of local manufacture in the foreseeable future, efforts should be made to encourage suppliers to provide servicing and spare parts in the country.

The use of private contractors to carry out aspects of Government programmes is commonplace throughout the world; its virtues (competitive costs and efficiency) and its problems (favouritism and kickbacks) are well known. In water well installation, boreholes may be sunk to the wrong depth or corners may be cut on below-ground casing to finish the borehole quickly. These problems often lead to unnecessarily high rates of borehole failure. Rigorous monitoring procedures, with the explicit purpose of managerial improvement and cost reduction, improve performance. The forms of contract used and opportunities for legal redress against inadequate work, need scrutiny.

Systems of checking and verifying may increase bureaucracy; but without them, the service will be poor and the users will have no confidence in its reliability. The service's reliability is a prerequisite for health impact.

Transferring part of the responsibility for service maintenance and operation into the community may lead to resistance from many parts of the institutional establishment. The technicians tend to believe that local people are incapable of taking on any quasi-professional or para-technical role. The political establishment may look askance on the idea of inviting local people to contribute

to the service for different reasons. Some technical or managerial personnel may feel their jobs (or informal means used to supplement a frequently meager income) threatened.

The first stage of such a transferral may be best handled by using local handymen for simple handpump repairs and latrine construction and remunerating them partly from community sources and partly by means of subsidy. The chance that they could be exploited by powerful local figures, or could themselves exploit the community may, thereby, be reduced. Also, the financial burden on the community may not feel too onerous at a stage when service credibility is not yet fully assured.

At stage 4: Community involvement

Community involvement in the installation of services should start with site selection - an area fraught with conflict. A handpump, a standpipe or a communal latrine may end up on private property, access to which can be controlled by the landowner. In many parts of the rural third world, no property is owned by women. This limitation on the power of women to have a say in water distribution, accessibility and use has to be recognized and dealt with in a realistic and constructive manner.

Service accessibility is the most important feature as far as the users are concerned. The evidence suggests that proximity to a water point determines the health impact of a water supply system as much as the water quality. Therefore, apart from geophysical feasibility, the view of the community, particularly women, on where services should be installed should be the basis of such decisions. If they can be placed on common land, so much the better.

"Community" decisions in traditional rural areas, however, may not be reached by methods considered democratic. The presence in a community of a strong and public-spirited NGO or a fair-minded leader may help to offset the influence of traditional authority. But it is normal to find that better-off households, just as they are usually closer to roads, shops and other local amenities, similarly manage to be closer to water supply points. This should not be seen entirely as a disadvantage. Better-off householders are usually better-educated and demand a higher quality of life. They are therefore more likely to take action promptly if the service breaks down and have the resources to pay for repairs or exercise enough influence to have them carried out.

The area most commonly associated with community participation is maintenance; but the community does have to be properly equipped and rarely is. The usual way of facilitating the process is by creating a mechanism for the selection of people from the community to be trained as "handpump caretakers". In its original concept, handpump caretaking principally meant reporting breakdowns speedily to the authorities and carrying out a little preventive maintenance. However, the concept has been extended to include the training of a "barefoot mechanic" cadre. It can sometimes mean

"pump supervisor and manager" and, when it includes women caretakers, usually means "public health educator".

Where handpump caretakers or village handymen are employed to carry out repairs or build latrines, they may have to be remunerated. Women may be willing to carry out certain caretaking duties and health education duties voluntarily, but men are not likely to remain motivated without some incentive. If they are remunerated by the PHE authorities, they become an extra layer tacked onto the edge of the public service and the concept of community ownership of the service remains remote. If they are remunerated by the community, then, unless the community already has a "community chest" arrangement that can stand the extra strain, it may have to create a mechanism to pay them.

The "mechanism" in Bangladesh is that the richest householder in the neighborhood, one who probably has the best access to the pump, pays for the repair. (This system is an updated version of traditional arrangements for the provision and maintenance of village water supplies.) Elsewhere, revolving loan funds or other savings arrangements may be needed. What is least desired is that the local authorities collect money from the users and put it in a revenue account without either being clearly accountable or involving the community in its disbursement.

Ensuring that community-level workers are part of an administrative structure and have organizational back-up from an NGO (perhaps one established by themselves) or from the authorities is as important, if not more important, than remuneration. A sense of status, of self-esteem and of usefulness can provide forceful motivation and an inspiration for other kinds of community development activity.

The third area of potential community involvement is health education. In the Indian programme, the only agents of health education linked directly to the national RWSS programme are the relatively insignificant numbers of women handpump caretakers. There are also some special projects, such as the Integrated Guinea Worm Eradication Programme in Rajasthan and many smaller NGO projects that use "social animators" or other types of community volunteer as public health care agents. In Bangladesh, the handpump mechanics, the lowest level of technical cadre employed in PHE, are beginning to take on the role of health educators. In Nigeria, a special cadre of village-based workers (VBWs) has been trained and other community groups such as mothers' clubs are being used.

These approaches to participatory health education differ quite significantly from one another. In their different ways, programmes must take account of socio-cultural considerations, including the status of women, ease or otherwise of communications and problems of remuneration. The difference between these specific approaches also indicate that national authorities attach different levels of importance to health education activity. Although the question of how much of an impact water supplies and sanitation services can independently exert on community health will continue to be debated, it is now widely regarded as axiomatic that

without an active health education programme, health impact will fall far short of its full potential.

Because the design of truly effective water- and sanitation-related health education programmes must be specific to a socio-economic-cultural environment and cannot follow a given strategic formula, it is important to introduce methods of measuring the performance of the cadre of agents selected and trained. Possible steps include using latrine compartment/borehole ratios to ascertain the local rate of latrine construction; faecal coliform counts in household water storage jars; the reported caseloads of environment-related disease at local health clinics; the per capita daily water use; and personal, domestic and environmental cleanliness.

At stage 5: A consumer-driven service

This stage in the RWSS national programme has not been reached by any of the three analyzed for this study. Given that India has the largest and most advanced rural water supply programme in the developing world and that Bangladesh has as long a programme history, it seems likely that no national RWSS programme in the developing world has yet reached this stage. It therefore represents a stage, however speculative at present, to which programmes should aspire.

In this study, Bangladesh's is the programme closest to the consumer-driven stage; but, like all programmes, it is far further advanced in water supply than in sanitation and it is greatly assisted by hydrogeological conditions and the unusual technological simplicity and low cost of water well installation.

Reaching the consumer-driven stage requires the transfer of most aspects of installation of both water supply and sanitation services, as well as their maintenance and operation, into the private sector. It requires that demand for the services reach the point where better-off households and some less well-off households, put their own resources into providing them for themselves.

For demand to have reached a point where it significantly influences supply, there must be a wide public appreciation for the benefits of a given service. In the case of water and sanitation, convenience and modesty will begin to be supplemented by a felt need to maintain a higher standard of domestic and personal cleanliness. This will drive up rates of daily water consumption per head for washing and bathing, and encourage latrine construction and the use of clean water for all household purposes.

The role of the PHE authorities in this scenario is not diminished (because the geographical spread of service coverage is so high that there are proportionately more installations to oversee), but it is altered. Certain functions must be undertaken by the public sector: hydrogeological mapping and monitoring of ground and surface water availability; overall policy for the sector; establishment of technical standards and managerial strategies; policing of quality, both of technological components and of service maintenance; R&D and the ground-breaking work associated with the

introduction of any new technology; supervision of training curricula from village through university levels in all fields associated with rural PHE; and many other supervisory and quality control responsibilities that are supportive rather than operational.

The main tension in the consumer-driven approach is that since the public authorities exercise less control over operations, there is less opportunity (theoretically) to determine the distribution of installations and their costs to consumers according to principles of social equity. The poor are less well-served by any demand- or supply-driven approach because, as consumers, they have fewer resources to deploy. Therefore, it will be a continuing role of Government to ensure that the consumer-driven service is organized and subsidized in such a way that the poorest members of society are not cut off from its benefits.

Whether it is desirable to meet the costs of installation and repair of a community service out of public revenue collection, by depending on patrician or charitable support, or from a community chest, will depend on local creed and circumstances. The less well-off developing countries cannot aspire to universal coverage of RWSS from an already overstretched national purse, especially in view of other contemporary budgetary pressures. The international community and many national programmes have, therefore, begun to advocate that RWSS programmes make it a key policy to devolve onto service users all the maintenance costs and part or all of the installation costs.

This cost-sharing measure is designed to increase community ownership and, therefore, foster "sustainability" of services as well as to enable an acceleration of service delivery. The phrase used to describe the spread of the financial burden to the users is "cost recovery", which is another way of saying that the users will have to pay for services in one way or another. Although this area of tension is obscured by the vocabulary, the problem of balancing public subsidies with private entrepreneurship is a conundrum confronted by all Governments trying to meet the rising costs of quality social services. There is far from being any formula yet available for resolving this conundrum in RWSS programmes in the poorer parts of the world.

Just as those least well-off financially need protection regarding the spread of services, the least well-endowed with education and social awareness will need most attention from health education campaigns. While reaching them may be relatively low-cost technologically, it requires proportionately more resources on the software side. Not only do users of services need to understand the benefits of cleanliness to health, but they need to have enough knowledge of the service, how it should perform and what it should cost, to be able to judge whether they are well or badly served. Consumer complaint, particularly when voiced by an organized group, is a good mechanism for service improvement. If the community does not appreciate the importance of using clean water only and disposing properly of waste, its members will be apathetic about service quality and continuity. If they are well informed and well organized, they can exert a critical influence.

In the consumer-driven stage, therefore, most mothers in the community will understand the importance of giving their children water to drink whose cleanliness is guaranteed; and of confining excreta and other wastes to places where hands cannot touch them and cannot thereby transfer contamination to dress, bedding, eyes, mouth, body, food and all potential sources of bacterial infection. If either the water supply or sanitation services fail them, they will know who to go to and how to put the services back into functioning order. If extensions to the service are under discussion, both men and women in the community will not only be taking part in the discussion, but may well have initiated it and be saving money towards it.

This is the latest generation of problems confronting those trying to push ever outward the physical and conceptual frontier of RWSS programmes. Not surprisingly, problems become more complex as the complexity of service delivery increases. The most complex and sensitive areas in RWSS today are those with ideological and political connotations (public service versus private sector); and those trying to close the gap between the demand perceptions of users (access) and the supply perceptions of international donors (better health).

Many of the issues involved are specific to the nature of water and sanitation programmes; but in those developing countries facing crises of debt and budgetary cut-backs, questions of balance between public service responsibilities and private contributions are bound to arise increasingly in other social sectors. It is not easy to devise mechanisms whereby communities generate their own revenue outside the formal tax collection structure to pay for services delivered by public authorities, with built-in accountability to the contributors and protection against exploitative or incompetent officials or entrepreneurs. To achieve this, while upholding the principle of social equity as a cornerstone of development policy, will require a redefinition of the role of public authorities.

The International Drinking Water Supply and Sanitation Decade set a challenge to which Bangladesh, India and Nigeria have clearly responded. Will other national programmes, some of which languish well behind those described here, manage to navigate their own versions of the earlier generations of problems? Perhaps, by 1995, they will be ready to face "sustainability", "cost recovery" and "health impact" with greater confidence than those confronting these challenges today.

Meanwhile, a new generation of challenges will have emerged...

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